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ABSTRACT

Developed for use primarily with middle school age students, this introductory booklet provides a sample of innovative activities that integrate mathematics skills with science processes. The investigations employ a wide variety of readily available and easily understood materials. The 25 activities are sequenced from simple to complex according to the science processes of: (1) observing and classifying; (2) measuring; (3) estimating, predicting, and hypothesizing; (4) controlling variables; (5) gathering and recording data; (6) interpreting data; and (7) applying and generalizing. Each activity consists of student sheets and a teacher's guide. The teacher's guide contains background information and suggestions for classroom management, instruction, discussion, and program extension. (ML)

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MATH + SCIENCE
A Solution

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BOOK 1 INTRODUCTORY INVESTIGATIONS

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INTRODUCTORY INVESTIGATIONS

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Project AIMS

Project AIMS has as its purpose the integration of subject matter in K-9. Such integration enriches and makes learning meaningful and holistic. Project AIMS began as a program to integrate mathematics and science, but has since developed to also include language arts, social studies, and other disciplines. The acronym "AIMS" stands for "activities to integrate mathematics and science."

Project AIMS is a continuing, non-profit project of Fresno Pacific College. It had its inception in a National Science Foundation funded program to train teachers in the integration of mathematics and science. This quickly created the necessity to write instructional materials incorporating this concept. Despite the fact that thoughtful educators have long recommended this approach, very little appropriate material was available.

Currently, Project AIMS is funded solely through the sale of this developing series of books. All net proceeds from their sale flow into a trust fund administered by Fresno Pacific College. The use of this fund is restricted to the support of continued research and development, partial scholarships for classroom teachers who participate in the writing and field testing teams, and the publication of the books.

Two writing teams have completed their work. The first consisted of seventy-five teachers in grades 5-9 who met over a period of eighteen months. The second involved thirty-five K-4 teachers who wrote during a two-year span. In the fall of 1985 a third team of approximately fifty teachers in grades 2-9 will begin writing. In addition, over a hundred teachers have been involved in field testing newly created materials.

The rationale for this integrative thrust lies in the fact that science, mathematics, language arts, social studies, etc., are integrally interwoven in the real world outside the classroom, from which it follows that they should be similarly treated in the classroom if we are to prepare our students for life in that world. Teachers who have used Project AIMS lessons give enthusiastic endorsement to the effectiveness of this approach.

Science encompasses the art of questioning, investigating, hypothesizing, and discovering. Mathematics is the language that provides clarity, objectivity, and understanding. The language arts provide us with powerful tools of communication. Many of the major contemporary issues involve societal issues stemming from advancements in science. It is time, therefore, that all of us in the teaching profession take seriously using a more holistic mode of transmitting knowledge to students. It is this that motivates all of us who are involved in creating or using the integrative materials of Project AIMS. We invite you to join us in this effort.

Extensive field testing of these materials confirms the following beneficial results.

1. Mathematics becomes more meaningful, hence more useful, when it is applied to situations that interest students.

2. The extent to which science is studied and understood is increased, with a significant economy of time resulting from the integration of two or more disciplines.

3. There is improved quality of learning and retention, supporting the thesis that learning which is meaningful and relevant is more effective.

4. Motivation and involvement are increased dramatically as students investigate real world situations and participate actively in the process.

We invite you to become part of this classroom teacher movement by using an integrated approach and by sharing any suggestions you may have or investigations you would recommend. Project AIMS welcomes you!

Project AIMS Publications

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Math + Science, A Solution
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Fun With Foods
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Down to Earth
Our Wonderful World
Pieces and Patterns, A Patchwork in Math and Science

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I HEAR, AND I FORGET

I SEE, AND I REMEMBER

I DO, AND I UNDERSTAND

–Chinese Proverb

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The Foundation is devoting every effort to making its materials and educational programs affordable. With respect to publications this takes the form of offering books with reproducible lesson material at a reasonable initial cost and then granting generous duplication rights. But, there are restrictions to the duplication rights that must be strictly observed.

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Introduction to Book One

The Introductory Booklet may be described as a sampler of innovative activities that correlate mathematics and science in a unique and exciting way. These highly motivating investigations invite students and teachers to explore, discover, and enjoy the many fascinating elements of our real world. The investigations employ a wide variety of readily available and easily understood materials—from marbles and M and M's to old shoes and rubber balls.

The twenty-five investigations presented here are sequenced from simple to complex according to these science processes:

A. Observing and Classifying

B. Measuring

C. Estimating, Predicting, and Hypothesizing

D. Controlling Variables

E. Gathering and Recording Data

F. Interpreting Data

G. Applying and Generalizing

While the experiences are ordered in this manner, be encouraged to select any of the activities you wish to supplement your own curriculum.

It is the sincere desire of the writing team that these curricular materials will encourage and challenge teachers and students in their endeavor to integrate math and science.

AIMS Newsletter Subscription Information

Each issue of the AIMS Newsletter contains a wealth of resources consisting of new AIMS integrated mathematics/science investigations, simple science experiments, and problem solving mathematics activities.

The AIMS Newsletter is published monthly, August through May. Subscriptions are on an annual basis only. A subscription entered at any time will receive the 10 issues for that year beginning with the previous August issue. This format is used since many of the articles in an annual volume are interrelated and all need to be available for maximum benefit.

The average issue of an AIMS Newsletter contains four or more new AIMS investigations, at least one each at the K-2, 3-5, and 6-9 grade levels; one 8.5 x 11 inch blackline master poster describing a simple science experiment; two 8.5 x 11 inch blackline master posters displaying problem solving situations; information about developments in the AIMS program, workshops, courses, and other activities; feature articles of lasting value dealing with science instruction problem solving in mathematics, etc.; a description of how a school, district, or state is implementing AIMS in a systemmatic manner; activities by members of the AIMS National Leadership Network and the writing teams; a thorough preview of all new AIMS and SETUP publications; information about conference presentations by the program directors of AIMS where participants can meet with them personally; and a periodic listing of all AIMS publications.

The problem solving poster series in the Newsletter is accompanied by a thorough analysis of problem-solving approaches appropriate to each situation. This analysis serves as an aid to classroom teachers who wish to enhance their own knowledge of problem solving and helping students acquire an inventory of problem-solving skills. Authored by Wilbert Reimer and Arthur Wiebe, both of whom studied extensively under Dr. George Polya at Stanford University, both series reflect his influence.

The ten issues in the annual volume contain forty or more new AIMS investigations, ten science posters, and twenty problem-solving challenges, plus numerous articles dealing with the teaching of "hands-on" science, evaluating higher order thinking skills and student progress in mastering process skills, and other enriching resources.

Since duplication rights for one school site are granted for all materials published in the Newsletter, it is highly cost effective for a school to enter a subscription and build a library for the use of all of its teachers.

The annual subcription price is $22.50. The entire first volume of ten issues (1986-7) is still available for $22.50. Schools purchasing the first volume and entering a subscription for the second year (1987-8) may do so at the reduced price of $40.00 for both. The number of sets of Volume 1 is limited, however, and early purchase is recommended.

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The AIMS Newsletter is published monthly, August through May. All subscriptions are on an annual basis only. A subscription entered at any time during the year will include all issues of that year beginning with the previous August issue.

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Materials:
Procedure:
COMMON CENTS
Do all pennies have approximately the same mass?
TRIANGULAR NUMBERS
Triangular numbers are numbers which can be represented by dots in an equilateral triangular array. The first four triangular numbers are pictured below.
Rubber
TEDDY BEARS
Playing in the Den
Your task is to make the best guess as to how many Teddy Bears there are of each color.
Blue Red Green
First Sample
Second Sample
Third Sample
Fourth Sample
Total
Auburn, AIMS, Action!
Activity Centered Science Partnership
AIMS NEWSLETTER
A Publication of the AIMS Education Foundation
AIMS On Target In China
Chinese Students Measure Up
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A Publication of the AIMS Education Foundation
A Non Profit Tax Exempt Foundation
AIMS Education Foundation Outlines Five-Year Plan
Circumference
Estimate
Measure
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Basic Operations and the Model of Mathematics
The TEDDY BEARS Go Sledding
AIMS NEWSLETTER
A Publication of the AIMS Education Foundation
Hawaii Selects AIMS for Statewide Program
Diagonal Challenge
Find the total number of diagonals in a polygon with 12 sides by first examining a polygon with 3 sides, then a polygon with 4 sides, etc. until you see the pattern that appears. Use the chart to record your results.
Number of Sides
Number of Diagonals
The Fascinating Triangle
EGG FACTS

It's A SHOE-IN!

I. **Topic Area**

Observation and classification.

II. **Introductory Statement**

In this activity, students will use their own shoes and those of their classmates to develop observational skills. Shoe characteristics will be sketched or listed on the student sheet. A guessing game format is used to make the activity even more appealing.

III.

Math Skills	**Science Processes**
a. Attributes	a. Observing
b. Set Theory	b. Classifying
c. Venn Diagrams (optional)	c. Recording Data

IV. **Materials (per class)**

A large pile of 20 or more student shoes
Student Worksheet, Page 1

V. **Key Question**

"Can you guess the characteristic being used to sort the shoes?"

VI. **Background Information**

Attributes or characteristics that may be used include: shoe color, shoe type, shoe lace color, type of sole, etc.

VII. **Management Suggestions**

1. Have students stand or sit in a semi-circle around the pile of shoes.
2. Students should put both of their shoes in the pile.
3. The estimated time required for this investigation is one class period of 45-60 minutes.

VIII. **Procedure**

1. A pile of as many different shoes as possible is collected from the students and placed on the floor.
2. The teacher announces that he/she will begin sorting the shoes into two piles by following some rule, based on one characteristic or attribute.
3. The students are to guess the rule by which the teacher is sorting.
4. Students who think they know the rule can finish sorting the pile using that rule, one student at a time, so that the teacher can make sure that his/her guess is correct.

5. After the pile has been sorted, and the rule discussed, return all shoes to the pile and begin sorting by another rule.
6. The teacher should initially sort the pile using one characteristic as the rule, such as: one pile of brown shoes and one pile of shoes that are not brown. After several such trials the teacher should try sorting the pile using two or more characteristics as the rule, such as: one pile of brown shoes with heels and one pile of all the other shoes.
7. After this activity has been repeated several times, students are to sketch and label five different shoe characteristics or attributes that were used in sorting, using boxes 2-6 on the "Shoe Sort" student worksheet. Or the student worksheet may be used to simply *list* the various attributes.

IX. **What the Students Will Do**

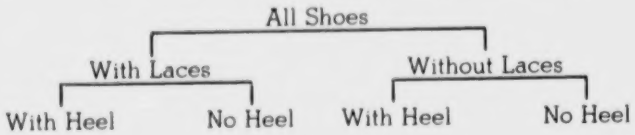
1. Guess or identify the characteristics being used to sort.
2. Sketch and label, or list five shoe characteristics used in this activity.

X. **Discussion**

1. What attribute do all the shoes have in common? (Worn on feet, all have soles, etc.)
2. How many attributes does a simple object such as a shoe have? (Many, several, etc.)
3. What are some attributes that most shoes have? (Answers might include laces, no heels, soles, etc.)
4. What are some attributes that few shoes have? (Answers might include purple color, heels, etc.)

XI. **Extension**

1. A complete list of their classmates' personal attributes could be compiled and graphed.
2. Venn diagrams could be constructed to show some of the observed characteristics.
3. By using pictures of animals, students could develop their own lists of animal attributes.
4. Students could make tree diagrams like the one shown below to sort and classify their shoes.



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Unique U

I. **Topic Area**

Observation and classification.

II. **Introductory Statement**

The students are to sort themselves according to their attributes (sex, hair color, type of clothing, etc.) until each student is in a group by himself/herself. In searching for a solution, students will learn a great deal about attributes that make them the same and different from everyone else in the class.

III. **Math Skills**

a. Logical Thinking
b. Sorting
c. Problem Solving

Science Processes

a. Observing
b. Classifying
c. Recording Data

IV. **Materials**

Sorting tree on a transparency of Student Worksheet, pages 2-3.
Student Worksheets, pages 2-3.
Overhead projector and screen.

V. **Key Question**

"What attributes make you a unique and special person?"

VI. **Background Information**

The students will be looking for attributes relevant to particular members of a group. They will choose from among these attributes to discover a category into which to place themselves. They will use a tree diagram which has two branches at every separation point.

VII. **Management Suggestions**

1. Estimated time: one 45 minute class period.

VIII. **Procedure**

1. When students come to a consensus on an attribute, the teacher will record this attribute on the overhead transparency. This will be done for each decision.
2. Starting with the whole class, the students will decide how to divide themselves into two groups based on one attribute.
3. The groups will move to opposite sides of the room.
4. Each of these groups will divide itself into two groups based on one attribute which need not be the same for each group. These will separate themselves into four places in the classroom.
5. This process will continue until each person is by himself or herself.
6. As soon as any student is by himself or herself, that student returns to his or her seat and traces his or her own particular attributes on the sorting tree. See the sample copy for these examples: Mary Jane is a student, a girl with long hair, and she is tall; Bobby is a student, a boy with short hair, and he is short.
7. A typical procedure might be as follows:

Teacher: "What is one way you can sort yourselves into two groups?"
Students: "Boys and girls." (Students do so.)
Teacher: "Can you divide each group again?"
Students: "Long hair and short hair." (Students divide again.)
Teacher: "How many groups are there now?"
Students: "Four."

IX. **What the Students Will Do**

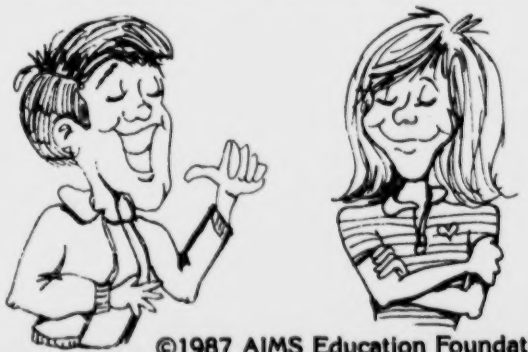
1. Students will sort themselves according to various attributes of their choosing.
2. Each student will trace his or her own attributes on a tree diagram.

X. **Discussion**

1. Which attributes are the most general? (Those on the left side of the tree diagram.)
2. Which attributes are the most specific? (Those on the right side of the tree diagram.)
3. Which attributes made you a special and unique person in this classroom? (Answers will vary.)

XI. **Extension**

1. Sort buttons using the following attributes: 2 hole or 4 hole; round or straight; big or little; brown or not brown; etc. Other attributes may be selected by students.
2. Sort leaves by having students collect leaves. Use attributes such as: needles or whole leaves; branched or unbranched leaves; rough or smooth edged leaves; fine or coarse veined leaves; heart shaped or arrowhead shaped leaves; etc.
3. Classify animals by listing different kinds of animals on the overhead and having students sort the animals according to physical attributes.



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On Your Own Two Feet

I. **Topic Area**

Observation and classification.

II. **Introductory Statement**

In this investigation, the students will observe and record the characteristics or attributes of their different shoes. By recording these characteristics on a data table, they will be able to identify a mystery shoe. A statistical analysis of these shoes will reveal the percentage of each type of shoe in the class, percentages of shoes with heels and laces, and a graphic representation of shoe sizes.

III. **Math Skills**

a. Attributes
b. Logical Thinking
c. Computing Percent
d. Graphing

Science Processes

a. Observing
b. Classifying
c. Recording Data

IV. **Materials**

One shoe from each student.
Roll of masking tape.
Student Worksheets, pages 4-5.

V. **Key Questions**

1. Can you identify the mystery shoe based on its characteristics?
2. What percentage of your class is wearing tennis or running shoes?
3. What percentage of your class is wearing shoes with heels?
4. What percentage of your class is wearing shoes with laces?
5. What is the most common shoe size in your class?

VI. **Background Information**

1. To compute the percent of each type: divide the number of that type by the total number of shoes and multiply by 100.
2. Possible materials for soles might include leather, rubber, canvas, plastic, etc.

VII. **Management Suggestions**

1. Have all students place one of their shoes in a pile on the floor.
2. Using masking tape, number each shoe with a different number.
3. Estimated time to complete this investigation is one or two 45 minute class periods.

VIII. **Procedure**

Part I

1. Distribute one or more of Student Worksheet, page 4, depending on the total number of shoes in the pile.
2. Number each shoe with masking tape.
3. Start passing each shoe from student to student. Each student is to record the necessary information about each shoe in terms of the ten (10) characteristics shown at the top of the Student Worksheet.
4. When the students have recorded this information for all the shoes in the pile, the shoes are once again returned to the pile.
5. The teacher then picks up a shoe, removes the number (so that the students cannot see it), and begins describing some of its characteristics.
6. The first student to guess the correct shoe number gets to pick a shoe from the pile, remove the number, and describe the shoe's characteristics to the other students.

Part II

Use the information tabulated on Student Worksheet, page 4 to determine percentage of each shoe type, percent with heels, percent with laces, and the shoe size graph. (Student Worksheet, page 5)

IX. **What the Students Will Do**

1. Complete a data table that will compare each of the shoes in a pile for ten different shoe attributes.
2. Identify the mystery shoe by comparing the characteristics recorded on their data table with those described by the teacher.
3. Determine the class percentage for shoe type, shoes with heels, and shoes with laces.
4. Make a bar graph showing class shoe sizes and number of each size.

X. **Discussion**

1. If two different shoe numbers have all ten attributes the same, must they be the same type of shoe, exactly? (No, but probably very similar)
2. Which of the ten attributes would be most important in terms of comfort? (Size, shoe type, materials of shoe, heel, laces, etc.)
3. What are some other shoe attributes that we could observe? (New or old, round or square toe, over or under the ankle, etc.)

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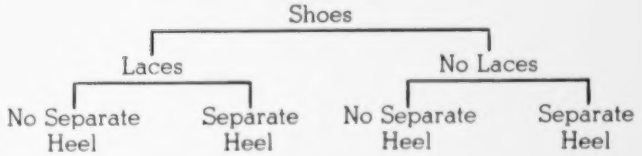
4. How many separate ways could we group the shoes based on one characteristic? (At least 10, probably more)
5. What are some other groups we could have? (Those with laces and a separate heel, those with laces that have leather soles, etc.)
6. Could you identify the shoe number when told just one attribute? (Probably not)
7. Is it possible to know all ten attributes and still be unable to identify the shoe's number? (Yes, two shoes might have all ten attributes the same, but still be slightly different)
8. Is this a true statement? The more attributes you know about any object, the easier it is to identify it. (Yes)

XI. **Extension**

1. The percentage for each of the ten attributes could be tabulated.
2. Instead of using percent, fractions or ratios could be used.
3. Branching keys, or dichotomous keys could be constructed using these or other shoe attributes. (See next page, "How to use a Dichotomous Key.")

Branching



Dichotomous

1A Has Laces 2
1B No Laces 7
2A Separate Heel 3
2B No Separate Heel 5
3A Rubber Sole 4
3B No Rubber Sole 8

4. Measurements of body height could be made, and graphically compared to shoe sizes to see if a correlation exists.

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Sorting All Sorts

I. **Topic Area**

Observation and classification.

II. **Introductory Statement**

In this classification lesson, students will sort a set of at least ten containers into as many groups of two as possible. The students will group or sort the containers based on characteristics of their own choosing. A guessing game format is used to make this lesson more appealing.

III. **Math Skills**

a. Sorting
b. Logic
c. Problem Solving

Science Processes

a. Observing
b. Classifying
c. Recording Data

IV. **Materials (per group)**

A set of at least ten different containers.
Masking tape.
Student Worksheet, page 6.

V. **Key Question**

"How many ways can you sort containers into two groups?"

VI. **Background Information**

1. The students will probably use the following characteristics (or "rules") to sort their containers: *Color, No Color; Lids, No Lids; Labels, No Labels; Glass, Not Glass; Metal, Not Metal;* etc.
2. A DICHOTOMOUS KEY is a system for classifying elements of a set according to their distinguishing characteristics. In this system the set is first separated into two subsets. Step-by-step separation continues, in like manner, until each element is separate from all others. Thus, such a key can be useful for identifying the name of an object.
3. How to use a Dichotomous Key

   Take any U.S. coin and check it against the information shown at #1 of the key below. You will notice that under each number on the left there are two choices (comparisons): if your object (coin) does not satisfy one, it must satisfy the other. Thus, if your coin is silver in color, read the information shown at #2 of the key. If your coin is smaller than a penny, it is a "DIME." If it is larger than a penny, read the information shown at #3. Continue working down through the key, each time choosing the correct comparison until you arrive at an underlined name.

   The numbers shown at the right indicate the next comparison you must take ("where to go next"). The underlined words are the names. When you arrive at an underlined name, you have successfully "keyed out" your object.

Key to U.S. Coins

1. Silver colored.....2
   Not silver colored; copper colored....Penny
2. Smaller than penny.....Dime
   Larger than penny.....3
3. With a picture of a bird.....5
   Not with a bird, but with a bison (buffalo), a building or a bell.....4
4. With a bell (and B. Franklin)....Half-dollar
   With a "buffalo" or building.....Nickel
5. Bird in flying position.....Quarter
   Bird as if standing on branch with wings outstretched or clutching arrows in one claw.....6
6. With bust of George Washington on other side.....Quarter
   Without bust of G. Washington.....7
7. With eagle as on National Seal...Half-Dollar
   With eagle in side view, woman's figure on other side.....Half-dollar

VII. **Management Suggestions**

1. The estimated time for this investigation is one or two 45 minute class periods.
2. Make sure that your sets of containers are made of at least three different materials such as glass, metal, plastic, cardboard, etc.
3. Make sure that your sets of containers have at least three different shapes such as cylindrical, rectangular, etc.
4. Try to have some containers with and without lids and labels.
5. Before starting, label each different container with a different letter of the alphabet. Use masking tape to do this.
6. Student groups of 3 or 4 students work well in this activity.

VIII. **Procedure**

1. Each student group is to obtain a set of at least ten different containers. For identification purposes, each different container must be labeled with a different letter of the alphabet. This can be done with masking tape.
2. One student in the group is to start sorting these containers into two separate piles using a "rule" his or her own choosing...WITHOUT TELLING WHAT THE RULE IS! For example, containers with labels and containers without labels could be one such rule.

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3. The other students are to guess what the rule is. When a correct guess is made, the student who guessed correctly gets to sort next. However, before sorting the containers again, a record must be made on the Student Worksheet, page 6, showing the rule used and container types, using alphabet letters, that followed that rule. Example:

RULES	LETTERS
With Lids	B, D, F, I, J
Without Lids	A, C, E, G, H

4. After the record is made, all the containers are placed back into one pile, and a new student starts sorting the containers.
5. At the end of the period, ask each group to report how many different ways they were able to sort their containers into two groups.

IX. **What the Students Will Do**

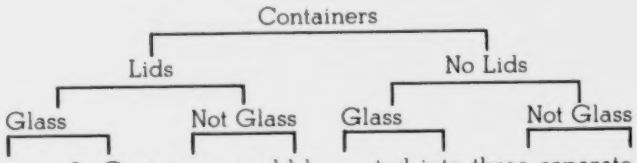
1. Sort various containers into two groups based on a rule of their own choosing.
2. Identify the rule being used by other group members to sort the containers.
3. Make a record of each of the different ways their group can sort the containers by listing the individual containers that followed each rule, using the alphabet letters to identify each container.

X. **Discussion**

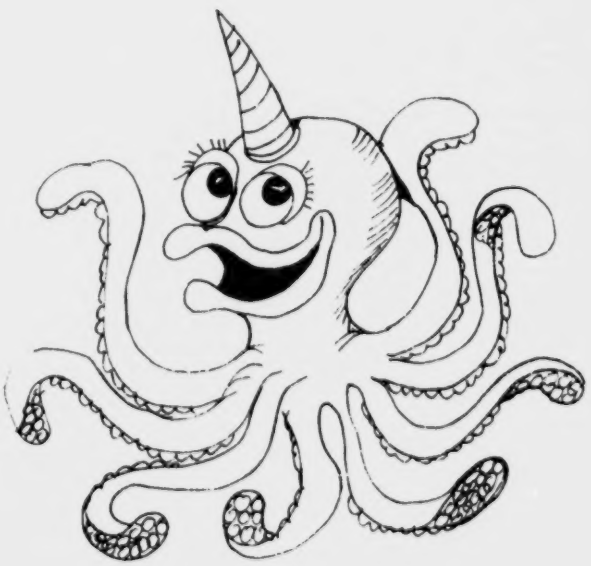
1. What kinds of objects are grouped by scientists for study? (Animals, plants, chemicals, stars, clouds, rocks, or practically everything they study)
2. What kinds of objects are grouped or sorted by non-scientists? (Coins, stamp books, pictures, tools, clothing, etc.)
3. What "rules" or characteristics would be useful in grouping or sorting people? (Height, weight, sex, race, marital status, place of birth, age, etc.)
4. What "rules" or characteristics would be useful in grouping or sorting numbers? (Odd or even, multiples, primes, squares, square roots)
5. Why do we sort or classify objects? (For organization, ease in remembering, decision making, etc.)

XI. **Extension**

1. Venn Diagrams could be made of the container letters, or of sketches of the containers made by the students.
2. A branching key like that shown below could be constructed by the students.



3. Containers could be sorted into three separate groups.
4. A DICHOTOMOUS KEY could be made for the set of containers.
5. Instead of using containers, students could follow the same procedure, only using the CREATURE'S FEATURES student sheet. Students may also want to give each creature a name! (Student Worksheet, pages 7-8)
6. A DICHOTOMOUS KEY could also be made for the "CREATURES".



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RULES	LETTERS
With Lids	B, D, F, I, J
Without Lids	A, C, E, G, H

4. After the record is made, all the containers are placed back into one pile, and a new student starts sorting the containers.
5. At the end of the period, ask each group to report how many different ways they were able to sort their containers into two groups.

IX. **What the Students Will Do**

1. Sort various containers into two groups based on a rule of their own choosing.
2. Identify the rule being used by other group members to sort the containers.
3. Make a record of each of the different ways their group can sort the containers by listing the individual containers that followed each rule, using the alphabet letters to identify each container.

X. **Discussion**

1. What kinds of objects are grouped by scientists for study? (Animals, plants, chemicals, stars, clouds, rocks, or practically everything they study)
2. What kinds of objects are grouped or sorted by non-scientists? (Coins, stamp books, pictures, tools, clothing, etc.)
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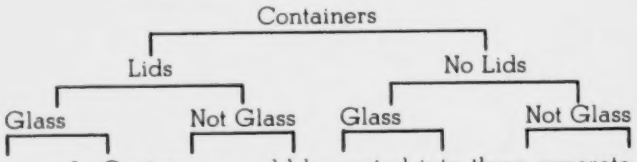

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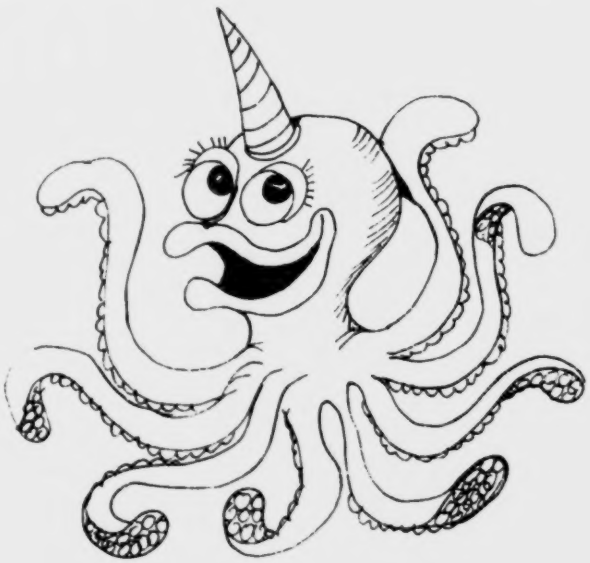
4. A DICHOTOMOUS KEY could be made for the set of containers.
5. Instead of using containers, students could follow the same procedure, only using the CREATURE'S FEATURES student sheet. Students may also want to give each creature a name! (Student Worksheet, pages 7-8)
6. A DICHOTOMOUS KEY could also be made for the "CREATURES".



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SUPER SLEUTH

I. **Topic Area**

Observing and Classifying.

II. **Introductory Statement**

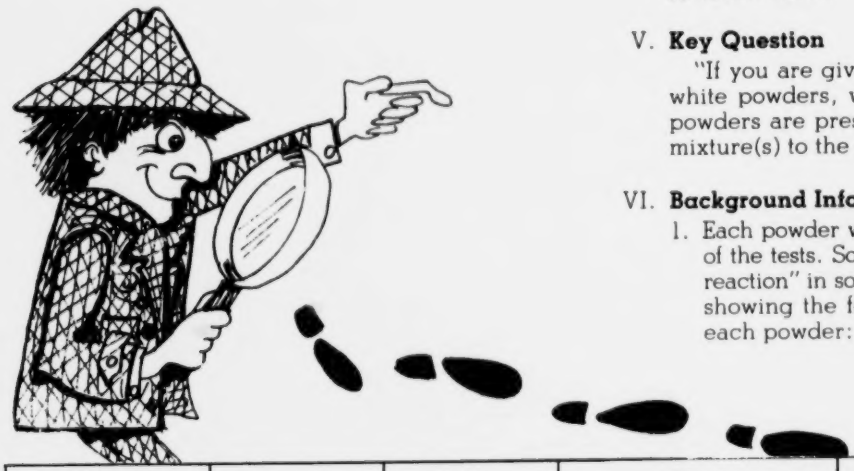
Students will be able to differentiate the characteristics of several items whose attributes are closely related. Students will discover that a critical eye and accurate record are of vital importance.

III. **Math Skills**

a. Logic

Science Processes

a. Observing
b. Classifying



IV. **Materials (per class)**

250 ml (one cup) of each of the following:

Sugar	White Flour
Salt	Powdered Milk
Baking Soda	Corn Starch

Thirty plastic drinking cups
Six teaspoons
One bottle of iodine with eye dropper
100 ml of cider vinegar with eye dropper
A source of heat (i.e. bunsen burner, hot plate, candle, etc. A hot plate works best.)
Several dozen (10 cm square) pieces of aluminum foil
Six microscopes or magnifying glasses
A water source

V. **Key Question**

"If you are given an unknown mixture of several white powders, will you be able to identify which powders are present?" (Teacher will show mystery mixture(s) to the class).

VI. **Background Information**

1. Each powder will react differently in at least one of the tests. Some of the powders will have a "no reaction" in some of the tests. Following is a table showing the four tests with the key reaction for each powder:

Powder Number	Vinegar Test	Iodine Test	Heat Test	Drawing
1 (Sugar)	No Reaction	No Reaction	Turns Black, Bubbles, Sweet Burning Smell	Crystal Shapes
2 (Salt)	No Reaction	No Reaction	Tiny Dents in Aluminum Foil	Cubic Shapes
3 (Baking Soda)	Fizzes	No Reaction	No Reaction	No Visible Texture
4 (Corn Starch)	No Reaction	Turns Dark Purple	Turns Brown, Slightly Sweet Smell	No Visible Texture
5 (Plaster of Paris)	No Reaction	No Reaction	No Reaction	No Visible Texture
6 (White Flour)	No Reaction	No Reaction	Turns Dark Brown, Smells Like Burnt Toast	No Visible Texture
Mystery Mixture	?	?	?	?

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VII. **Management Suggestions**

1. Estimated time: three to five 45 minute periods.
2. Groups of two work best.
3. The drawing area should be set up in one place with a small station for each powder.
4. The powder containers and the iodine, vinegar and heat tests should be set up in a separate area and under close teacher supervision.
5. One powder should be tested at a time but the order of the testing is up to the student.

VIII. **Procedure**

1. Each powder should be put in a container (Tupperware works well), each container is labeled from #1 - #6. A teaspoon is then placed in each container.
2. The teacher will tell students that there will be four tests for each powder. Each test will give different clues as to the various characteristics.
3. It is not important that you know the names of the powders; for each powder will be referred to only by its number.
4. The teacher will prepare six slides for the microscope...each one marked from #1 - #6 and each having a pinch of its corresponding powder placed on it.
5. Before class begins, the teacher will prepare a mystery mixture of any combination of powders in equal proportions.

IX. **What the Students Will Do**

1. Make a detailed drawing of the powder as viewed through the microscope.
2. Repeat steps #1 - #5 on the Student Worksheet for the remaining powders.
3. Now, take the teacher prepared mystery mixture, repeat steps #1 - #5 on the Student Worksheet and record reactions.
4. Compare mystery mixture data with the data from the six original powders.
5. Determine which powders (by number) are found in the mystery mixture.

X. **Discussion**

1. Can you identify any of the powders?
2. For what reasons is it important to be a good observer?
3. Why is observation especially important in science?
4. How could we tell the difference between these six powders?

XI. **Extension**

You may substitute other powders such as laundry detergent, joint compound, etc.; however, they should be white and nonpoisonous.

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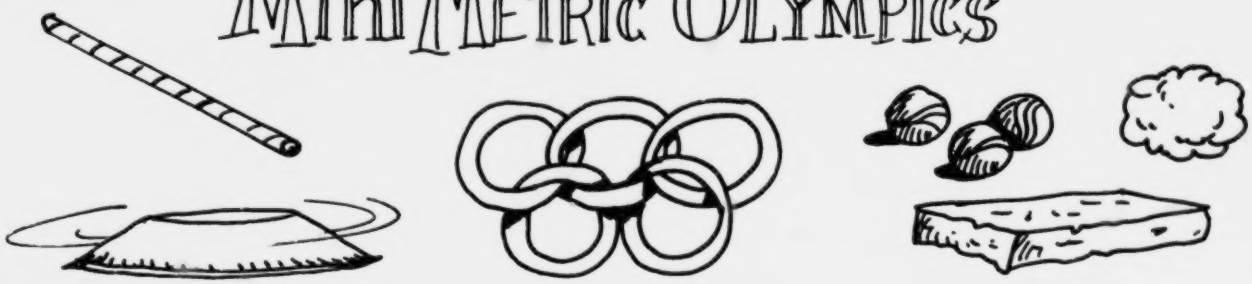
Mini Metric Olympics



I. **Topic Area**

Estimating and measuring in metric units.

II. **Introductory Statement**

Students will become familiar with metric units by estimating and measuring in a "Metric Olympic" setting.

III. **Math Skills**

a. Measuring in Metric Units.

Science Processes

a. Estimating
b. Predicting

IV. **Materials (per class)**

2-3 paper plates or pie pans
3-5 paper or plastic drinking straws
2 bags of marbles
3 meter sticks and meter tapes
cotton puff balls
large sponge
large mixing bowl or bucket
liter measuring set
centimeter graph paper
balance scale with weights
Student Worksheets, pages 10-17

V. **Key Question**

"How closely can you match your estimate and your actual measurement in metric units?"

VII. **Management Suggestions**

1. Establish fair ground rules ahead of time.
2. Be consistent in guiding rules that determine fairness in measurement. For Example: Do I get a practice turn?
3. Measure to the nearest whole unit.
4. Teacher needs to announce when teams will rotate to the next station.
5. Estimated time to complete activity is two (2) fifty minute class periods.

VIII. **Procedure**

1. Work in small groups (5) including a team captain.
2. There are a total of six stations with a different task at each station. Each station should have a task card with complete instructions and materials available. Each group is assigned to one station.
3. Each captain may read the instructions to his team. It is extremely important that *before* each activity begins, each student estimates and records his/her estimate on his/her student score sheet. Captains should check all members on the team before beginning any activity.
4. After each team member performs the activity, he/she measures and records his/her actual length, mass, volume or area.

IX. **What the Students Will Do**

After all the stations have been completed by all teams, each student should find the score, which is the difference between the estimates and the actual measurement for each event. This should be entered in the last column. Then each student totals the numbers in the score column. The winner is the one with the lowest score. You may wish to discuss how a low score shows accuracy.

Awards may be presented to the winners. There are forms in the student worksheet section which may be duplicated for this purpose. (See Worksheet, page 15).

XI. **Extension**

You may wish to use one or both of the self-explanatory extended activities: Metric Scavenger Hunt or Mini-Metric Olympics II. Mini-Metric Olympics II requires the computation of percent of error and is appropriate for the upper grades. See Student Worksheets, pages 16-17.

Following are other investigations that require estimation and measurement:

a. How many liters of water will fill your bathtub? Draw a cartoon and record your data.
b. Select five or more containers of assorted sizes and shapes. Can you arrange them in order from least to greatest and predict their volume accurately? Make a diagram and table of your results.
c. Select five or more objects of various sizes and shapes. Can you arrange them from lightest to heaviest and estimate their mass accurately? Organize and illustrate your data.
d. Estimate the distance of a trip to school and back home in metric units. Draw a map to scale that illustrates how far you walk or ride to school. You may choose to do this with a partner and do a combined map so that you can make comparisons.

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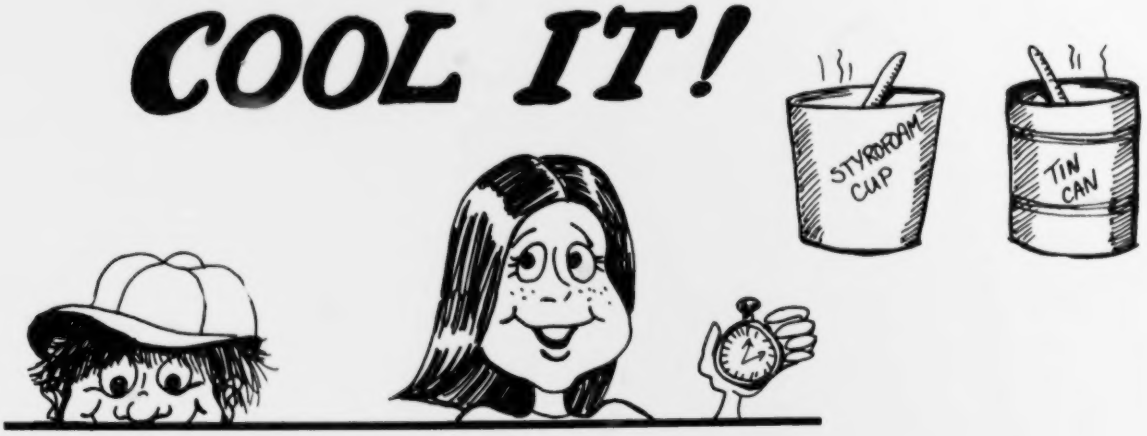
COOL IT!



I. **Topic Area**

Interpreting Data

II. **Introductory Statement**

Students will measure the length of time it takes hot water to cool in a styrofoam cup compared to the length of time it takes hot water to cool in a tin can. Upon completion of the activity, students will be able to determine which material is a better insulator for liquids, tin or styrofoam.

III. **Math Skills**

a. Observing
b. Measuring
c. Recording Data
d. Interpreting Data
e. Generalizing

Science Processes

a. Collecting Data
b. Comparing Data
c. Drawing Conclusions

IV. **Materials (per group)**

1 styrofoam cup
1 clean tin can of the same volume
2 Celsius thermometers
1 stopwatch
1 liter container
Anything that will heat water to 75 degrees Celsius
Student Worksheet, page 18

V. **Key Question**

"In which container will the hot water retain its heat longer? Why?

VII. **Management Suggestions**

1. Have the students work in small groups.
2. Provide each group with the appropriate materials.
3. Estimated time: One 45 minute period.
4. Practice reading thermometers.
5. Record to the nearest degree.

VIII. **Procedure**

1. Heat water to at least 75 degrees Celsius.
2. Students will pour 200 ml of water with a temperature of 75 degrees Celsius or higher into each container as quickly as possible. They must be careful not to touch the water.
3. Students will insert a Celsius thermometer into each container.
4. Students begin taking readings as soon as the thermometers stop rising and they record the temperature.
5. A student starts a stopwatch at this point.
6. Students take and record readings on the thermometers in one minute intervals.
7. Students record the results each minute for both thermometers.
8. They must record the temperature at its highest point first and then continue at one minute intervals for 15 minutes.
9. After completing the temperature data record, the students construct a line graph showing the temperatures of the water in each container.
10. Students record the results on the same graph using two different colors, one color for each container's results.
11. The results of the graph are then studied.

IX. **What the Students Will Do**

1. Measure the temperature of water using Celsius thermometers.
2. Record temperatures at one minute intervals for fifteen minutes.
3. Construct a line graph.

X. **Discussion**

Encourage the students to draw conclusions about the relationship between the time it took the water to cool in one container compared to the other container.

XI. **Extension**

Instead of using only two containers, use several kinds (tin, plastic, glass, etc.).

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HOT STUFF

I. **Topic Area**
Measuring Temperature

II. **Introductory Statement**
Students will discover which materials make the best insulators.

III. **Math Skills**
a. Measuring Temperature
b. Graphing

Science Processes
a. Observing
b. Measuring Temperature
c. Recording Data
d. Interpreting Data

IV. **Materials (per group)**
Timer for each group
Hot water (75° C.)
Container to measure 300 ml of water
Aluminum soda pop cans with pull-off tabs
Deeper cans such as those used for fruit and vegetable juices
Celsius thermometer for each group
Materials to be used as insulators (four or more of the following): sawdust, cotton, shredded paper, vermiculite, fiber glass, sand, foam plastic (such as that used for packaging), and air.
Student Worksheets, pages 19-20.

V. **Key Question**
"Which insulation material will keep the water hot the longest?

VII. **Management Suggestions**
1. Have different groups work on different insulators and compile the results for the class.
2. Use three students in each group—one for timing, one for reading the temperature and one for recording.
3. Estimated time: one or two 45 minute class periods.

VIII. **Procedure**
Instructions for setting up insulated cans.
1. Using the insulator you want to test, place at least 2-3 cm (one inch) of material in the bottom of the outside container.
2. Set the inside container on this, centering it in the outside container.
3. Pack the space in between with the same insulation.

Procedure for completing the investigation.
1. Pour 300 ml of water with a temperature of about 75° Celsius into the aluminum can.
2. Insert the thermometer into the water.
3. As soon as the temperature reaches 70° C., start the timer.
4. Record the temperature every minute for fifteen minutes.
5. Have students graph the results.

IX. **What the Students Will Do**
1. Select various insulators for testing.
2. Accurately measure 300 ml of water for testing.
3. Record temperatures every minute for 15 minutes.
4. Graph temperatures for each insulator.

X. **Discussion Questions**
1. Which material let the water cool off fastest?
2. Which material kept the water warm the longest?
3. Which material is the best insulator?

XI. **Extension**
More capable students with more time could test more than one material. Some may wish to extend the investigation to find the best possible insulator.

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Corny Comparison

I. **Topic Area**

Measurement of volume

II. **Introductory Statement**

Students will practice measuring volume in metric units. Students will find the ratio of popped to unpopped popcorn.

III. **Math Skills**

a. Measuring Volume in Metric Units
b. Determining Ratios

Science Processes

a. Measuring
b. Predicting
c. Controlling Variables
d. Recording Data
e. Generalizing

IV. **Materials (per class)**

Popcorn popper - more than one may be helpful
A supply of two brands of popcorn
Oil
Graduated cylinders or cups that measure in milliliters, one set for each group
Student Worksheet, page 21

V. **Key Question**

"How much will the volume of popcorn expand when it is popped?"

VI. **Background Information**

To find the ratio of popped to unpopped corn, measure each using the graduated cylinder or cups. For example, if the investigation using 130 ml of corn produces 950 ml of popped corn, the ratio of popped to unpopped is 950:130. However, it is more convenient to work with 1, so we divide both numbers by 130 and get the ratio 7.3:1. We interpret this to say that the volume of popped corn is 7.3 times the volume of the unpopped corn.

VII. **Management Suggestions**

1. Have an adult supervise the popping of the corn.
2. Have everyone make their estimate before the first group pops their popcorn.
3. Alternate between brands to minimize differences in conditions.
4. Estimated time: two to four 45 minute class periods.
5. The class will divide into eight groups and each group will perform one popcorn popping experiment.
6. Assign the groups as follows:

Group		Volume of Popcorn	Volume of Oil
1	Brand A	70 ml.	20 ml.
2		100 ml.	30 ml.
3		130 ml.	40 ml.
4		160 ml.	50 ml.
5	Brand B	70 ml.	20 ml.
6		100 ml.	30 ml.
7		130 ml.	40 ml.
8		160 ml.	50 ml.

IX. **What the Students Will Do**

1. Each student will first estimate the volume of the popped corn for his or her particular group.
2. Each group will pop their popcorn and measure the volume, then make a record of the results.
3. Each group will calculate the ratio of the popped corn to the unpopped corn.
4. All groups will share their data.

X. **Discussion**

1. How much did the popcorn increase in volume?
2. Who came the closest to predicting the correct volume?
3. Compare the ratio of the predicted and actual results, popped to unpopped corn.
4. Which brand gave the best results?
5. Which brand is the most expensive?
6. Is the difference in cost worth it?

XI. **Extension**

1. Students could determine the cost of a liter of popped corn for each brand and make a direct comparison.
2. Students could determine in what volume they would like to sell popcorn (1 liter, 1.5 liter, etc.) and then determine how much popcorn they would need to buy to sell a hundred bags of popcorn.
3. If students do (2) above, they could also compute the cost per bag of the popcorn alone or the popcorn and the oil. This still ignores the cost of labor and electricity.

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Weight Watchers

I. **Topic Area**

Estimating and measuring mass.

II. **Introductory Statement**

Weight Watchers is an activity that requires students to estimate and measure mass.

III. **Math Skills**

a. Measuring
b. Estimating
c. Computing Ratio and Percent (optional)
d. Using Calculators (optional)
e. Averaging

Science Processes

a. Observing
b. Measuring
c. Predicting and Estimating
d. Recording Data

IV. **Materials (per group)**

Golf ball
Marble
Wooden block that weighs less than, but is larger than the golf ball
Tennis ball
Ping Pong ball
Clay ball
Equal arm balance with Metric mass set
Student Worksheet, page 22

V. **Key Question**

"Can you order the objects from heaviest to lightest using only visual clues?"

VI. **Background Information**

The difference between the estimated mass and the actual mass, divided by the actual mass, multiplied by 100 equals the percent of error.

$$\frac{\text{difference}}{\text{actual mass}} \times 100 = \%\text{ of error}$$

Examples:

Item	Estimated Mass in Grams	Actual Mass in Grams	Percent of Error
Golf Ball	20	35	43%
Marble	15	10	50%

Golf Ball

Actual mass 35
Estimated mass −20
Absolute difference 15

Actual mass $35\overline{)15.000}$ = .428 Rounded off equals .43

14 0
1 00
70
300
280
20

.43 × 100 = 43%

Marble

Estimated mass 15
Actual mass −10
5

Actual mass $10\overline{)5.00}$ = .50

5 0

.50 × 100 = 50%

VII. **Management Suggestions**

This activity can be done in small groups or in a whole group activity. The activity can be done in one 45 minute class period.

VIII. **Procedure**

Collect all the necessary materials mentioned in the Materials Section IV. Give each student a copy of the worksheet. Place the objects where all the students can see them. Go through the worksheet step by step with the students. It might be helpful to make an overhead transparency of the worksheet and explain to the students before you begin what they will be doing.

IX. **What the Students Will Do**

1. The students will order the objects from the heaviest to the lightest visually and record their guess.
2. The students will estimate the mass of each object.
3. The students can work in small groups and weigh the objects while the rest of the class watches.
4. All the students will record the actual mass in grams.
5. Students will find and record the difference between the actual mass and estimated mass.

Students may stop at this point. If the teacher feels that students are capable, the teacher may have the students continue to fill in the chart. This is a good opportunity to have students use calculators.

Optional

6. Have students find their average error. A small prize could be awarded to the student with the lowest average error.
7. Have students find the ratio.
8. Have students convert the ratio to a decimal.
9. Have students compute the percent of error.

X. **Discussion**

1. Is there a way the estimations can be checked for accuracy?
2. Can you estimate the mass of the objects in grams and then find the actual mass in grams?
3. Discuss with the students what their rationale for ordering the items from heaviest to lightest was.

XI. **Extension**

Provide each student with a chart that has all the items left out. Let the students choose 6 items of which they would like to estimate the mass and then continue on with the mathematical calculations. (see Student Worksheet, 23).

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SECOND GUESSING

I. **Topic Area**

Estimating and Recording Data

II. **Introductory Statement**

Students will compete to see which students are able to estimate time accurately.

III. **Math Skills**

a. Estimation
b. Ratio
c. Percent
d. Timing

Science Processes

a. Estimating
b. Recording Data

IV. **Materials**

Clock or watches with second hand or a stop watch
Recording sheets
Student Worksheet, page 24

V. **Key Question**

"Who can guess when 30 seconds have passed?" Have students close their eyes and raise their hands when they guess 30 seconds have passed.

VII. **Management Suggestions**

1. Estimated time: one 45 minute class period.
2. You will need one time piece for every two students. (The classroom clock may be used if it has a second hand)
3. Students need to be familiar with ratio in whatever form you plan to use.
4. If the investigation is done in a learning center, only one stop watch is needed.
5. Calculators can be used for the division, if the teacher desires.

VIII. **Procedure**

1. Students will work in pairs to estimate time.
2. One student will act as the timer; the other as the estimator. (Students must switch roles so that all students have a chance to do both.)
3. The timer selects a time period, such as 60 seconds, and tells the estimator to raise his/her hand when he thinks 60 seconds are up. The timer records the actual time period in the table under the column "Time Estimate".
4. The timer may then tell the estimator how many seconds actually passed.
5. The estimator should repeat the exercise (Trial 2) trying to estimate this same time period.
6. Repeat using other time periods and do each time period at least twice.

IX. **What the Students Will Do**

1. Students will estimate time. One student estimates a given length of time (with his back to the clock) while the other student monitors the actual time.
2. Students will find the difference between the estimate and the actual time passed. This is called "the error of estimate".
3. Students will find the ratio of the error to the time period.
4. Students will express the ratio as a decimal and then as a percent.

X. **Discussion**

1. How well did you estimate? Did your estimates improve with practice or did they become poorer?
2. How were you able to make a fairly accurate estimate?
3. Are some people better at estimating than others?
4. What methods are best for estimating?
5. Why are clocks and watches needed to measure time?

XI. **Extension**

1. For grades 7-8, do the percent error. Graph the results.

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Chaotic Computing!

I. **Topic Area**

This is a study of the effect of distractions on studying.

II. **Introductory Statement**

This is a study of the effect of distractions on studying.

III. **Math Skills**

a. Timing
b. Whole Number Computations

Science Processes

a. Recording Data
b. Controlling Variables

IV. **Materials**

Student Worksheets, pages 25-29
Stop watch or clock with second hand

V. **Key Question**

"Do I study better with or without distractions?"

VI. **Background Information**

The control of variables is an extremely important concept in scientific experimentation. A *variable* is any factor that can change or cause a change in an experiment. Scientists seek to control all variables except the one being tested. For example, if we want to know the effect of distraction on problem solving, distraction is the variable we want to study. Other variables such as time of day, difficulty of the problems, or method of distraction must be controlled. In this way, if we find a difference in computational ability, we can be fairly certain that it was caused only by the distraction and not a different factor.

VII. **Management Suggestions**

1. Discuss the type of problems that will be worked.
2. Review subtraction of time with the students before beginning.
3. If your room doesn't have a clock with a second hand, you can write the beginning times on the chalkboard. As the students finish, have them raise their hands and write the ending times on the board.
4. Note: Some students will work better with distraction.

IX. **What the Students Will Do**

1. a. Students will work the 20 problems in Set A without distraction.
   b. They will record the beginning times on their worksheets.
   c. As they finish, each will quietly write down the ending time.
   d. Each will compute the length of time required.
2. a. Each student will find a partner to do Set B.
   b. One student will read the list of numbers on the student worksheet as many times as necessary. This will provide a distraction to the student working the problems.
   c. Students will compute and record the length of time required to complete the set of problems.
   d. Partners will switch places and repeat steps a, b, and c.
3. Correct the problems and record the number correct on the tables.

X. **Discussion Questions**

1. Which problem set did you complete faster?
2. On which problems were you most accurate?
3. What seems to be affected more-- speed or accuracy?
4. What do your results suggest about your ability to study with or without distraction?
5. Would we have different results if we reversed the investigation? (working with distraction first; then working without distraction).

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Set B (Level 1) **Chaotic Computing!**

5 +8 = 13	11 −4 = 7	137 −49 = 88	135 +87 = 222
8 −6 = 2	321 −57 = 264	5 +27 = 32	748 +77 = 825
69 +32 = 101	424 +386 = 810	145 −126 = 19	17 −9 = 8
13 +97 = 110	403 −304 = 99	573 −477 = 96	7977 +8744 = 16,721
5273 −3827 = 1446	62,785 −38,068 = 24,717	142,348 +161,764 = 304,112	557,863 −456,954 = 100,909

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Set A (Level 1) **Chaotic Computing!**

12 −3 = 9	152 −74 = 78	8 +7 = 15	193 +89 = 282
231 −78 = 153	837 +68 = 905	4 −1 = 3	29 +3 = 32
127 −108 = 19	58 +43 = 101	473 +237 = 710	13 −7 = 6
743 −648 = 95	302 −203 = 99	48 +9 = 57	8723 +7999 = 16,722
6382 −4525 = 1857	71,523 −42,634 = 28,889	174,875 +131,239 = 306,114	573,641 −472,732 = 100,909

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Set B (Level 2) **Chaotic Computing!**

8 x9 = 72	54 ÷ 9 = 6	6 x7 = 42	24 ÷ 8 = 3
32 x4 = 128	831 x6 = 4986	72r4 6|436	4200 ÷ 60 = 70
236 x9 = 2124	903 x5 = 4515	40r3 5|203	9600 ÷ 10 = 960
396 x32 = 12,672	765 x29 = 22,185	308 x13 = 4004	331r22 23|7635
306 x604 = 184,824	813 x134 = 108,942	496 x109 = 54,064	6934 x943 = 6,538,762

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Set A (Level 2) **Chaotic Computing!**

9 x5 = 45	42 ÷ 7 = 6	3 x8 = 24	72 ÷ 8 = 9
42 x3 = 126	613 x8 = 4904	61r5 8|493	3500 ÷ 70 = 50
623 x9 = 5607	309 x5 = 1545	60r2 5|302	4500 ÷ 100 = 45
693 x23 = 15,939	576 x92 = 52,992	803 x31 = 24,893	210r15 32|6735
406 x603 = 244,818	314 x138 = 43,332	964 x901 = 868,564	3964 x349 = 1,383,436

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"It's Simply Marbleous"

I. **Topic Area**

Interpreting Data and Controlling Variables

II. **Introductory Statement**

A marble will be rolled down an inclined plane several times from different heights. Upon the completion of this activity, students will be able to describe the relationship between the slope of an incline plane and the distance an object will roll.

III. **Math Skills**

a. Averaging
b. Graphing
c. Measuring
d. Adding

Science Processes

a. Collecting Data
b. Predicting/Estimating
c. Observing
d. Measuring
e. Recording Data
f. Interpreting Data
g. Controlling Variables

IV. **Materials (per group)**

16 books (each with a spine about 2cm in width)
2 meter sticks
1 marble
1 metric tape measure
masking tape
Student Worksheets, pages 30-31

V. **Key Question**

"How does the slope of an incline plane affect the distance a marble will roll?"

VI. **Background Information**

Generally, the steeper the slope, the farther the marble will roll. Eventually, the height of the slope will become so steep that the marble will not continue to roll as far as it did previously. This is due to the fact that the forward motion of the marble is absorbed into the floor.

VII. **Management Suggestions**

1. Estimated time: One 45 minute period.
2. Demonstrate this activity to the students by setting up the inclined plane.
3. Find a fairly open area which has smooth carpeting or use a sheet spread on the floor. The texture of the surface on which a marble rolls will be a factor in how far it rolls.
4. Attach about 5 cm of masking tape to the metric rulers at the top and bottom so there is a separation wide enough for a marble to roll down.
5. Place one book with a 2 cm spine on the floor. From the edge of the book spine mark a baseline 88 cm with a piece of tape.
6. Place the meter sticks on top of the book so that the ends of the meter sticks meet the 88 cm tape mark on the floor.
7. Practice gently placing the marble in the groove and releasing it from the edge of the book spine, so the marble can roll freely from the ramp. Measure the distance the marble rolls.
8. Explain to the students that this is the process they are to use in the experiment. Discuss the importance of controlling all variables (keeping everything the same except for the height of the ramp).

VIII. **Procedure**

1. Distribute the necessary materials.
2. Have the students work in small groups and set up the experiment.
3. Each group should have the student worksheets.
4. Each group should have one person to roll the marble, one or two to mark where the marble stops. Each student records the measurement on his individual worksheet.
5. Students are to roll the marble five times each at heights of 2 cm, 4 cm, 8 cm, 16 cm, 32 cm. They must always maintain a base of 88 cm. The marble must be released each time at the edge of the book spine.
6. The students measure the distance the marble rolls each time it is released.
7. Students record the measurement in cm on the data table.
8. They then find the average for each height and record it on the data table.
9. Students then complete the graph.

IX. **What the Students Will Do**

1. Measure the distance the marbles roll.
2. Record measurements in Data Table.
3. Total and average the trials for each height.
4. Graph the average distances.

X. **Discussion**

1. Did the height of the slope increase the distance the marble rolled? Why? Why not? (Yes, the marble has more potential (stored) energy with greater height.)
2. If the slope keeps getting steeper, will the marble roll farther each time? Why? Why not? (Up to a point, yes. When the slope is completely vertical, the marble will not roll far because its energy is absorbed by the ground.

XI. **Extension**

1. Use different sized marbles.
2. Use different spheres – golfballs, ball bearing, etc.
3. Use different surfaces – rug, cement, dirt, table top, etc.

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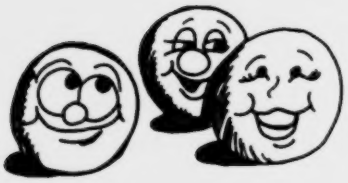
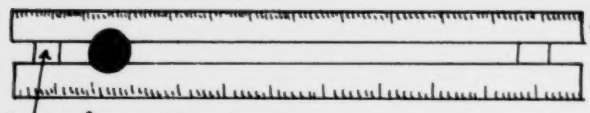


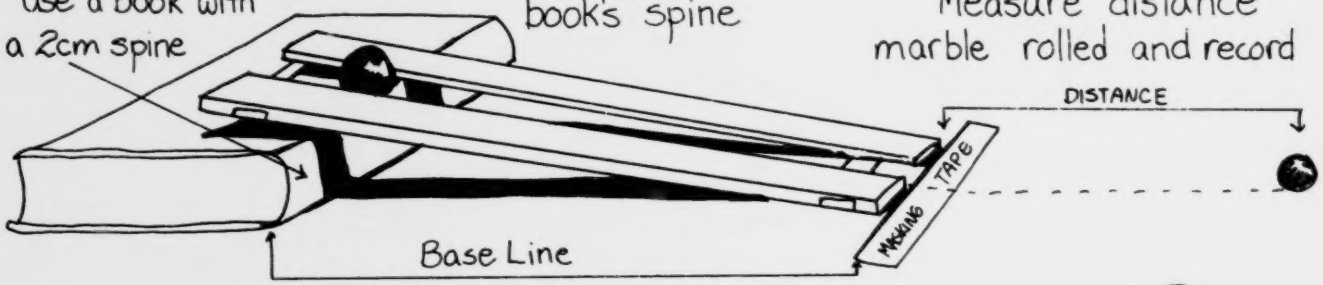
Construct a ramp for the marble



Start the marble from the book's spine

Use a book with a 2cm spine

Measure distance marble rolled and record



Mark and Keep Base Line at 88cm

How does the slope of the ramp affect the distance a marble will roll?

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M&M's Count & Crunch

I. **Topic Area**

Gathering and Recording Data

II. **Introductory Statement**

In this investigation, students will determine the numerical frequency of the five colors of M & M plain candies. After the students have found the most frequent color of this popular candy, they will be rewarded by being allowed to eat 'em up!

III. **Math Skills**

a. Whole Numbers
b. Percents
c. Fractions
d. Decimals

Science Processes

a. Observing
b. Classifying
c. Predicting/Estimating
d. Recording Data
e. Interpreting Data

IV. **Materials (per group)**

One small package of M & M plain candies
Pencil and crayons
Student Worksheet, page 32

V. **Key Question**

"What is the most frequent color of M & M's?"

VI. **Background Information**

1. To find the percentage of each color, divide the number of the color by the total number in the bag and multiply by 100.

   Example:

   .44 × 100 = 44%

   total number in bag → 50 | 22.00 ← number of a color...add a decimal point, two zeros, and divide

   −20

   2 00

2. To find the ratio (fractional part) of each color, use the total number as the denominator and the number of each color as the numerator.

   Example:

   number of a color → 22 = 11 ← reduced

   total number in bag → 50 25

3. Cost per M & M is determined by dividing the cost by the total number of M & M's.

   Example:

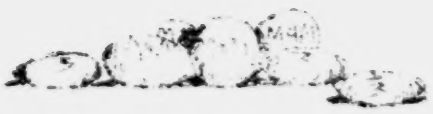
   .006 × 100 = .6¢ per M & M

   total number in bag → 50 | .300 ← add a "0" so you can divide

   cost per package (.300 = $.30)

4. Sample data table with figures:

	Total No. of M & M's	No. of Green	Ratio	% of Gr.	No. of Orange	Ratio	% of Or.	No. of Yellow	Ratio	% of Yel.	No. of Lt. Brown
Prediction	40	4	4/40	10	12	12/40	30	2	2/40	5	10
Actual	50	4	4/50	8	8	8/50	16	10	10/50	20	6



VII. **Management Suggestions**

1. Estimated time: one or two 45 minute periods.
2. Groups of two or more are recommended.
3. Students should record their own data.
4. Express ratios according to the appropriate ability level of your students.
5. Students should be aware before you begin that the candies are not to be eaten until the investigation is completed.
6. Pocket calculators are great for computational work.

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VIII. **Procedure**

1. Before opening the package, have students predict and record the total number of candies, the colors present, and the number of each color.
2. Open the package. Observe and sort according to color.
3. Record data in the table provided.
4. Calculate fractional or percentage parts of the total.
5. Graph the actual percentage of each color.

IX. **What the Students Will Do**

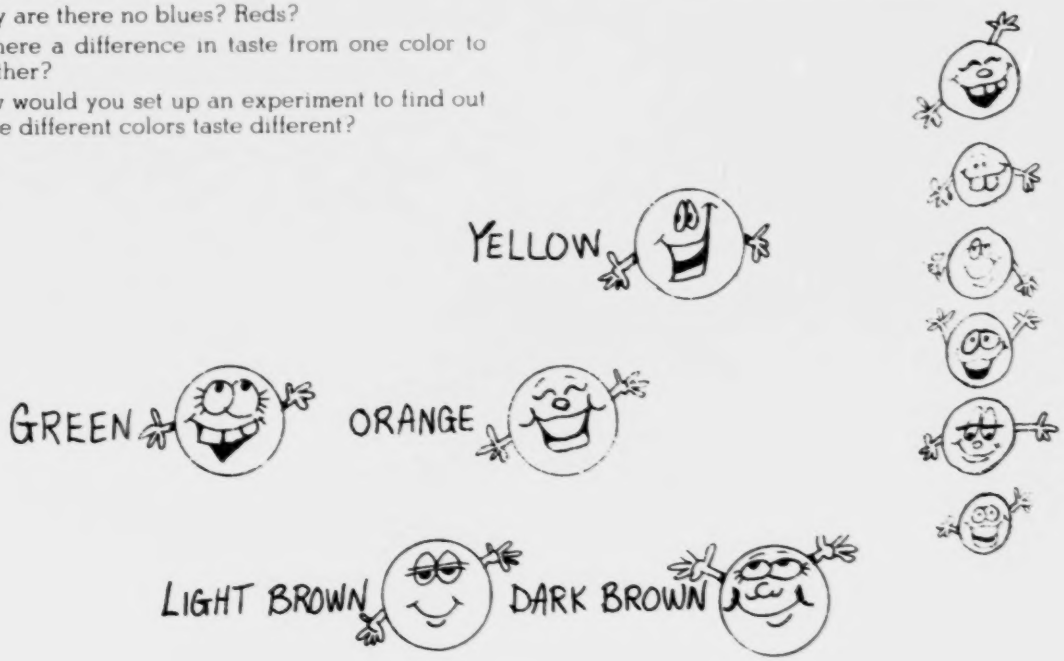
1. Predict color and content of a bag of M & M's.
2. Count and record actual numbers, ratios and percents in the data table.
3. Design a bar graph.

X. **Discussion**

1. What was the most common color? Least common?
2. Why do you think there are more browns than other colors?
3. Why do you think M & M's have been so popular over the years?
4. Why are there no blues? Reds?
5. Is there a difference in taste from one color to another?
6. How would you set up an experiment to find out if the different colors taste different?

XI. **Extension**

1. Do this investigation using M & M peanut candies as a comparison.
2. This investigation may also be done with other candies that come in assorted colors. i.e.: Life Savers, gum balls, etc.
3. Have students construct a bar graph where each color is represented using crayons, color pencils, or felt pens. The graph could demonstrate frequency of occurrence in any one of the three math operations mentioned here.
4. If you have metric balances, have students weigh the candies of their package. Compare with the weight listed on the package.
5. Have the students determine the cost per M & M.
6. Make a class chart or bar graph showing the results of the entire class. You may wish to include class averages on this chart.
7. The more capable students could change the ratios to decimals, then to percents.
8. Another M & M investigation for more capable students is M & M's "What's in the Bag" found on pages 36-37 in the teacher's manual.



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What's in the Bag?

I. **Topic Area**

Gathering and Recording Data

II. **Introductory Statement**

We will explore samples of bags of M & M's and attempt to determine if there are consistent patterns of manufacturing and packaging.

III. **Math Skills**

a. Adding
b. Dividing
c. Averaging
d. Graphing
e. Tabulating
f. Percent

Science Processes

a. Recording Data
b. Collecting Data
c. Identifying and Controlling the Variables
d. Hypothesizing
e. Interpreting and Predicting

IV. **Materials (per group)**

One bag of M & M's plain candies per group of three students
Colored pencils or crayons
Hand-held calculator (optional)
Student Worksheets, pages 33-34

V. **Key Question**

"Does the M & M Company package according to a systematic plan?"

VI. **Background Information**

Sampling is a technique that makes it possible to make predictions that reflect a larger group picture. In other words, "You don't have to eat the whole ox to know the meat is tough." By looking at sample bags of M & M's, students can predict anticipated outcomes. The larger the sample, the more accurate the results.

VII. **Management Suggestions**

1. Three people are to work with one package of M & M's—one to count, one to record, and one to compute—all can work on computation and graphing.
2. Estimated time: two to three 45 minute periods.
3. Encourage students to show results of their investigation in a variety of ways: narratives, line graphs, pictographs, circle graphs, demonstrations.

VIII. **Procedure**

1. Take as many samples as possible up to eight. Each bag represents a sample.
2. Record the total number of M & M's as the Number (N) for the mean and/or percentages.
3. Graph each of your samples by color.
4. By observation, establish the average number of each color. Then, compare this with the arithmetic mean (as seen on p. 33 of the student worksheets.)
5. Gather data from several groups in the class.
6. Determine percentages for each color in each sample; and for all samples as a whole.
7. Design a graph to show the percentage of each color for each of your samples.
8. Discuss the Key Question and record your conclusions.
9. Propose questions that need further investigation.

IX. **What the Students Will Do**

1. Students will predict the number of M & M's in their sample. Keep the Key Question in mind at all times.
2. Students will look for central tendencies throughout this whole experience. They will compute the percentage of each color in each sample, and the mean of each color for all samples.
3. Predict what the total number of M & M's might be from their sample data.

X. **Discussion**

1. Does the M & M Company package their product according to a plan? How does your data support or refute this idea?
2. What other products have similar packaging plans that might warrant further experimentation?

XI. **Extensions**

1. Other products such as canned foods—apricots, pears, peaches, etc.—can be sampled and predictions made about the quality and quantity of the product.
2. Letters could be sent to various companies regarding production control. Students may want to send a letter to the M & M/Mars Company, Division of Mars, Inc., Hackettstown, New Jersey, 07840 to check on the production ratios of M & M's...if there are any.

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DEALING WITH DATA

I. **Topic Area**

Gathering and Recording Data

II. **Introductory Statement**

Students are often called upon to record data in tables and to read data from them. Unfortunately, too infrequently are they given the hands-on opportunity to ponder the problems of data table design, let alone actually design one.

By providing students with such experiences we make it easier for them to understand the logical meaning and natural organization of the data they are called upon to record and read!

In this investigation of inherited traits the students will gain skill in the design and use of a simple data table. They will also gain skill in the use of ratio in a simple problem solving situation.

III. **Math Skills**

a. Counting
b. Ratio
c. Estimating
d. Sampling

Science Processes

a. Observing
b. Predicting
c. Gathering and Recording Data
d. Interpreting Data

IV. **Materials (per student)**

Paper
Pencil
Ruler
Student Worksheet, pages 35-36

V. **Key Question**

"What part of the school's population has the traits that you have?"

VI. **Background Information**

1. The trait pairs under study are "either/or" pairs.
2. The trait pairs under study are inherited.
3. In the key question we have written "WHAT PART OF THE SCHOOL'S POPULATION...," leaving it up to you, the classroom teacher, to pick the appropriate form in which the students are to express ratio (whole number, common fraction, decimal fraction, or percent).
4. Tongue rolling, widow's peak, and chin cleft are fairly common traits; ear wiggling is a rare trait.

VII. **Management Suggestions**

1. Students are to work in pairs.
2. One forty-five minute period is sufficient time for the data gathering and organizing. Often, the data interpretation and prediction revisions can be completed within the same period.
3. The typical student will require as much time to design and complete Data Table #4 as he/she requires to accomplish all previous tasks in the lesson.
4. Data for the whole class can be collected by student tally at the chalkboard or by show of hands as each trait is announced by the teacher.
5. The teacher will need to tell the students the size of the school's population.

VIII. **Procedure**

1. Ask the key question.
2. Provide materials.
3. Provide the correct figure for the school's population and direct students to complete Worksheet #1.
4. Provide a means by which the class data can be collected and summarized.
5. Direct the students to complete the Table of Class Data on Worksheet #2.
   NOTE: Traits must be filled in by students.
6. Ask the students to compare the class data with their original predictions; then direct the students to revise their predictions, construct a new data table in the space provided on Worksheet #2, and enter the revised predictions.

IX. **What the Students Will Do**

1. Each student will learn which trait of each pair he/she has and will check the appropriate boxes in Data Table #1.
2. Students will use their own data to help make a prediction about what part of the school's population has each of their own traits.
3. Students will complete the Class Data Table.
4. Students will compare class data to their predictions for the whole school and decide whether or not to make any revisions.
5. Whether or not the students choose to make revisions, they all should design and construct a new data table in the space provided.

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6. Students will participate in the discussion and in the extension activity, if any.

X. **Discussion**

1. What kinds of problems do you think people have when they are asked to design and use a data table?
2. In our investigation we used tables with four columns, each having two rows. Why do you suppose the designer of these tables used that design?
3. What are some other ways we could have organized our data?

XI. **Extension**

1. This investigation can be extended to include other traits. Students would be asked to design appropriate data tables.
2. Students could be asked to predict how many class members have 2, 3, and all 4 traits in common. They would then be directed to construct appropriate data tables in which predictions and actual counts could be recorded.
3. Traits showing continuous variation, such as height, could be investigated. Students would be asked to wrestle with the problem of fitting highly variable data into an appropriate table. This could provide an excellent transition to graphing.

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Practically Pi

I. **Topic Area**
Interpreting Data

II. **Introductory Statement**
Children will understand that "pi" is a constant relationship between the circumference and the diameter of any given circle.

III. **Math Skills**
a. Measuring
b. Graphing
c. Decimal computation

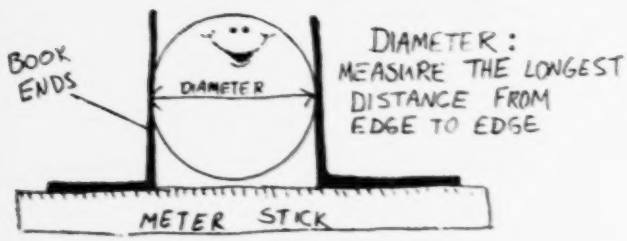
Science Processes
a. Organizing Data
b. Interpreting Data

IV. **Materials (per group)**
Assorted circular containers
1 lb. coffee can
2 lb. coffee can
Soup can
Juice can
Wheel
Waste basket
Metal bookends
Meter stick or tape
Chalk or marker
String
Student Worksheet, page 37

V. **Key Question**
"How does the circumference of any circle compare with its diameter?"
"Brent found that the distance around a circle was a little over 3 times the distance through the circle. Do you think it makes a difference what size circle he measured? Let's find out."

VII. **Management Suggestions**
1. For greatest degree of accuracy, measure to the nearest millimeter.
2. Review correct reading and writing of decimal numbers to the tenths place.
3. Estimated time: one 45 minute class period.

VIII. **Procedure**
1. Measure the diameter of each circular object (the longest distance from edge to edge).
One way to measure diameter:



2. Record the diameter of each object in appropriate table on Student Worksheet.
3. Measure the circumference of each circular object. The circumference is the distance around the circle.
One way to measure circumference is:
a. Wrap a tape measure or string around the cylinder near the base. Then measure the string or tape.

b. *Or* you may roll the cylinder one complete revolution along a meter stick or meter tape.

4. Record the circumference for each object in the table on the Student Worksheet.
5. Complete the Table:
Column C—Express each ratio as a fraction or decimal ratio.

Example: $\frac{C}{D}$ or C:D

Column D—Divide each circumference by its diameter and record the answer in Column D.

IX. **What the Students Will Do**
1. Measure and record the circumference and diameter of various objects according to the above procedure.
2. Record the relationship of circumference to diameter and compute the decimal equivalents.
3. Discover the "constancy" of the relationship of circumference to diameter.

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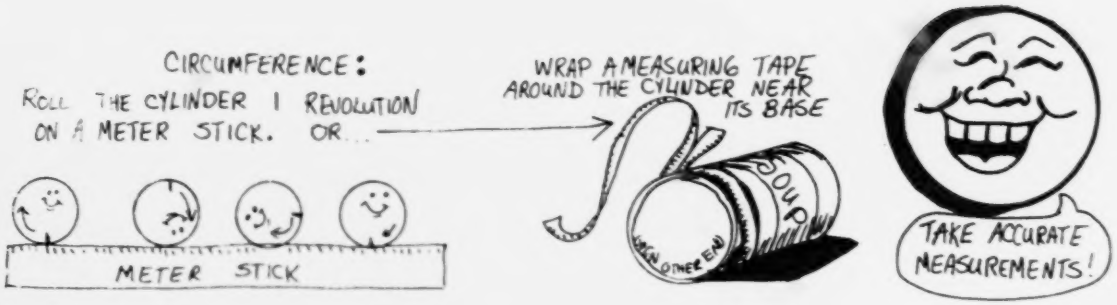
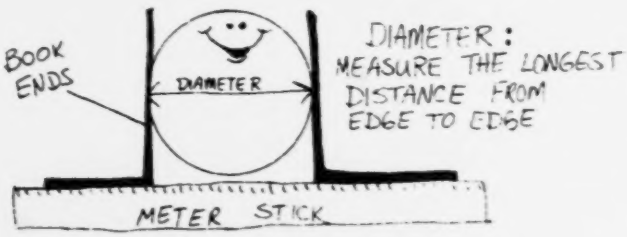
X. **Discussion**

1. *Observe:* What did you notice about the relationship between circumference and diameter in Column D? If you know the circumference of a circle, can you find the diameter? How? Can you find the circumference if you know the diameter? how?
2. What if you put the diameters and the circumferences measured into a graph? What would it look like? Use centimeter graph paper and try it!

XI. **Extension**

1. Introduce 3 unknown cylinders: A, B, and C. Give the diameters of A and B and the circumference of C. Can you find the missing figures?
2. Organize and record your data into a table. You may wish to draw a picture or cartoon also.


CIRCUMFERENCE:
ROLL THE CYLINDER 1 REVOLUTION ON A METER STICK. OR...
METER STICK
WRAP A MEASURING TAPE AROUND THE CYLINDER NEAR ITS BASE
SOUP
TAKE ACCURATE MEASUREMENTS!



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Just Drop It!

I. **Topic Area**

Interpreting Data

II. **Introductory Statement**

In this investigation, students will compare the amount of bounce that results from dropping different types of balls from various heights. The bounce resulting from dropping the balls on different surfaces can also be compared. From the collected data, a formula relating the height of bounce to the height of the drop will be developed. Using these formulas, students will be able to accurately predict how high a ball will bounce from any given height.

III. **Math Skills**

a. Formulating Equations
b. Graphing
c. Averaging

Science Processes

a. Interpreting Data
b. Applying and Generalizing

IV. **Materials (per group)**

One meter stick
At least two different types of balls to bounce
Student Worksheet, page 38

V. **Key Question**

"How is the bounce of a ball related to the height from which the ball is dropped?"

VI. **Background Information**

1. The data collected by dropping balls from an assortment of heights should result in a formula that shows the bounce to be proportional to the height of the drop.

   Bounce = unknown factor times height of the drop

   or

   $B = xh$

   Solving for x, $\boxed{x = \frac{B}{h}}$

2. A typical formula might be, $B = .55h$

   The unknown factor (.55) is obtained by dividing the height of drop (h) into the height of the bounce (B).

3. Each different type of ball will have a different unknown factor, but this value will always be between 0 and 1.

4. *Sample Outcomes:*

   Since .55 is most frequent, the formula would be B = .55 h (You may choose to average .72, .45, .59, .54, .59, .55, .55, .55, .54, .59 to determine your unknown factor, instead of simply picking the most frequently occurring number).

   The formula B = .55 h means that for the type of ball used, the ball will bounce approximately 55% of the height from which it is dropped (.55 = 55%).

Height of drop (cm)	10	20	30	40	50	60	70	80	90	100
Height of Bounce (cm) (average)	7.2	9.0	17.6	21.6	29.6	33.0	38.3	44.3	48.6	59.6
Bounce ÷ Height	.72	.45	.59	.55	.59	.55	.55	.55	.54	.59

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5. The data from the lower drop heights (10 cm, 20 cm, and 30 cm) will be the most inaccurate. Therefore, you may choose to omit this data when determining the formula for Bounce.
6. SUGGESTED BALLS: Tennis, Baseball, Ping Pong, Golf, Superball, Marbles. Each student group can do a different type of ball, or each group can test two or more different balls—teacher preference.
7. All bouncing heights and dropping heights are measured from the BOTTOM of the ball.

VII. **Management Suggestions**

1. ESTIMATED TIME: Three to four 45 minute periods.
2. Student groups of 3 or 4 work well. One can hold the meter stick, one can drop the ball, one can observe the bounce, and one can record the data.
3. To observe the bounce more accurately, the student should hold a piece of paper or cardboard at eye level in front of the meter stick. When the ball bounces, move the paper to the highest point the BOTTOM of the ball reaches. By sighting over the paper, the student can more easily read the measurement on the meter stick. A "hands and knees" observing position is a must—the observer must be at eye level with the ball at its highest point of bounce.
4. Hand calculators are greatly advised.
5. It is advisable to have all students use a hard floor or cement as their bouncing surface initially. Student groups that finish the investigation first can then be challenged to compare their results when a different surface is used.
6. It probably will be best to start your measurements with the 100 cm distance, and work down to the 10 cm distance. The lower height of drop distances are difficult to observe and measure.
7. If possible, you may wish to *start* all groups using the same type of ball in order to compare student data and measurement technique.

VIII. **Procedure**

1. Select the balls to be dropped.
2. Stand the meter stick vertically with the zero end down on the floor.
3. Place the bottom of the ball at the 10 cm mark of the meter stick. After releasing it, observe and record the total bounce in cm (distance from the floor to the highest point the bottom of the ball reaches at the peak of its bounce).
4. Repeat twice more for a total of three trials for each dropping height.
5. Repeat this same procedure for each of the remaining 9 dropping heights.
6. Record all data in the student sheet data table.
7. Plot the average height of bounce for each of the 10 dropping heights and construct a line graph.

IX. **What the Students Will Do**

1. Drop a ball 3 times for each of 10 dropping heights.
2. Record the height of the bounce for each trial on the data table.
3. Calculate the average height of bounce for each of the 10 dropping heights.
4. Construct a line graph of the data.
5. Write a formula relating B (height of bounce) to h (height of drop).

X. **Discussion**

1. Did any of the balls bounce as high or higher than the point from which it was dropped? (NO. A BALL WILL NEVER BOUNCE BACK UP TO THE POINT FROM WHICH IT WAS RELEASED).
2. What are some reasons that might explain why a ball can not bounce back up to the point from which it was released? (BECAUSE OF SUCH FACTORS AS AIR FRICTION, AND THE ABSORPTION OF ENERGY BY THE FLOOR, THE BALL LOSES ENERGY, AND THEREFORE CANNOT RETURN TO ITS PREVIOUS HEIGHT.)
3. The Bounce ÷ Drop Height numbers show what portion of the starting height (drop height) the ball is able to bounce up to. For any one ball, would you expect each of these numbers to be about the same, or different? (EACH TYPE OF BALL WILL BOUNCE A FIXED PORTION OF OF ITS STARTING HEIGHT. THAT PORTION IS THE UNKNOWN FACTOR. THE PURPOSE OF THIS INVESTIGATION IS TO EXPERIMENTALLY DETERMINE THIS UNKNOWN FACTOR. FOR ANY ONE BALL, THE BOUNCE ÷ DROP HEIGHT SHOULD BE ABOUT THE SAME. HOWEVER, THE LOWEST DROPPING HEIGHTS ARE DIFFICULT TO ACCURATELY MEASURE. THEREFORE, THESE COULD SHOW GREAT VARIATION. DIFFERENT TYPES OF BALLS SHOULD SHOW DIFFERENT BOUNCE ÷ DROP HEIGHT VALUES.)
4. If a certain ball has a bounce equal to .5 of the dropping height, predict the height of its bounce if dropped from a height of 10 feet. (BY USING THE FORMULA, B = xh, STUDENTS SHOULD BE ABLE TO SUBSTITUTE IN ANY GIVEN VALUE OF X TO DETERMINE OR PREDICT BOUNCE. IF h = 10 and x = .5 THEN .5 times 10 EQUALS *5 feet*.

XI. **Extension**

1. Inflate basketball with different amounts of air pressure. Find the relationship of air pressure to height of bounce.

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SCREEN TEST

I. Topic Area:
Searching for a representation of a million.

II. Introductory Statement:
Students will find how large a fiberglass insect screen needs to be in order to have approximately one million openings.

III. Math Skills
- Estimating
- Measuring to the nearest millimeter
- Computing areas
- Converting millimeters to centimeters
- Converting square centimeters to square meters
- Finding averages
- Using information from a table

Science Processes
- Observing
- Estimating
- Recording data
- Interpreting data
- Generalizing results

IV. Materials:
- 3 pieces of insect screen for each group
- Metric rulers marked in millimeters
- Screen Test worksheets
- Meter sticks

V. Key Question:
How much is a million? Can we see a million of something?

VI. Background Information
How many of us have an idea of what a million of something looks like? In this investigation, students will have extensive experience in finding areas as they search for a million openings in the insect screen. Thorough instruction in finding areas should precede the investigation. As they convert from square centimeters to square meters it is important to know that there are $100 \times 100 = 10{,}000$ square centimeters in a square meter. It takes about 2.4 square meters of insect screen to have a million openings or holes.

VII. Procedure
The fiberglass insect screen is available at little cost from building supply stores. A roll that measures over 12 square feet costs about $3.00. Only about one square foot is needed to supply the required number of pieces. The screen is easy to cut with a scissor and leaves no sharp protruding ends as would metal screen. When cutting the screen, follow vertical and horizontal threads with care. Most screens have holes that are not square. Therefore, to obtain fairly uniform results, the sample screens should be cut to be approximately, but not precisely, square - approximately 3 to 5 centimeters square. Each group should receive three pieces of differing dimensions.

Introductory Activities:
1. Project the image of a section of screen about 3×5 cm on the screen using an overhead projector. Leave the image on for about five seconds.
2. Announce that you want each team to determine their best strategy for estimating the number of openings. Tell them that you will project the screen for about thirty seconds during which time they can execute their strategy. Give the teams several minutes to determine their strategy before flashing the image on the screen.
3. Record the estimates of each team. Then have someone check the number of openings and report it to the class. Let each team compute their per cent of error by dividing the amount of difference between their estimate and the count by the actual count.

Next have students follow the steps as outlined on the worksheets. The following hints might be helpful.

a. By placing the screen into a corner, the work is simplified.
b. Millimeters are changed to centimeters by moving the decimal one place to the left.
c. The easy way to find the number of openings is to multiply the number in each row by the number of columns.
d. To find the number of openings per square centimeter divide the number of openings by the number of square centimeters.
e. To find the number of square meters of screen needed divide the number of square centimeters of screen by 10,000.
f. To find the average length per opening divide the number of openings in a row by the length of the row measured in centimeters. Similarly, find the average width per opening.

IX. Discussion
1. Why did the results differ?
2. What effect would it have on the count of openings per square centimeters if the shape of the screen would have been 8 cm long and 2 cm wide? (The difference allowed for each opening per unit of length and width is different so it would give different results depending on how the piece was cut from the original screen.)

X. Extension
Students might suggest other ways of finding a million. For example, if the school yard is surrounded by a link fence, they could find how many openings there are between posts and from that determine how many "post" lengths would have one million holes. Such a daily presence as that of the fence would be remembered a long time after such a calculation. This extension also finds application for the area formula.

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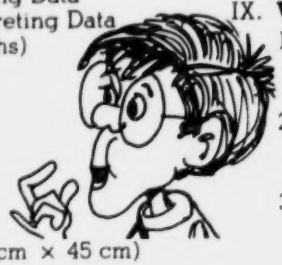
Trial & Error Learning

I. **Topic Area**
Interpreting Data

II. **Introductory Statement**
The student will discover that data from an investigation can be used to construct a model (graph) which can, in turn, be interpreted to provide information about real world events.

III. **Math Skills**
a. Telling and Recording Time
b. Time Computation
c. Minute to Second Conversion
d. Generalizing from Graphs

Science Processes
a. Gathering and Organizing Data
b. Interpreting Data (Graphs)



IV. **Materials**
Student Worksheets, pages 39-42
Clock with second hand
Construction paper 12" × 18" (30 cm × 45 cm)
"Scotch" type tape

V. **Key Question**
"How do you learn by trial and error?"

VI. **Background Information**
The maze can be stapled to a sheet of 12" × 18" construction paper for portability. A second sheet of construction paper with a 5/8" diameter hole in the center should cover the maze *at all times*.

VII. **Management Suggestions**
1. Each student is to work independently.
2. This activity requires one full 45 minute period on the first day, plus 15-25 minutes on each of the next two days.
3. The student will need to be reminded of the importance for timing each trial and for resisting the urge to mark on or peek at the maze.
4. For students who "forget" and peek, a different, but equivalent maze can be made easily by tracing the mirror image of the regular maze (turn the maze page over and trace).
5. Timing of each trial begins when the student first starts through the maze and ends only when the END is found or when 5 minutes of wandering has not been rewarded by finding the END.
6. The teacher should do this investigation beforehand in order to be prepared for unanticipated problems.

VIII. **Procedure**
1. Ask the key question.
2. Gently guide discussion to arrive at class consensus as to the precise meaning of the problem at hand.
3. Set up the mazes with construction paper covering the maze and the hole in the construction paper aligned with "START."
4. Provide necessary instruction concerning recording of starting and finishing times.
5. Point out that it is common for students to take more than 5 minutes to complete the maze during the first few trials.
6. Inform students that any times greater than 5 minutes should be recorded as 300 + seconds due to graph scale limit...or encourage students to design their own graph scales to accommodate times greater than 300 seconds.
7. Provide materials (worksheets, clock).

IX. **What the Student Will Do**
1. Each day for three consecutive days, or on each of three days spaced equally, the student will negotiate the maze 5 times.
2. The student will keep track of time taken for each trial by recording all starting and ending times in the data tables.
3. The student will graph each day's trials on the same graph, using pencil of different color for each day's trials. (The result will be three graph lines on the same graph paper).
4. The student will use his/her graph to find evidence of learning, forgetting, and maze mastery.

X. **Discussion**
Before Activity
1. KEY QUESTION—HOW DO YOU LEARN BY TRIAL AND ERROR?
2. Why does a mouse maze or rat maze seem so simple when viewed through human eyes? (Is it intelligence or just perspective?)
3. How would you set up a maze for humans so that you could have a fair contest between humans and rats?
4. Would it be important in a "trial and error learning" situation to keep the subject from seeing the whole maze at once?

After Activity
5. What evidence do you have that learning took place during the 5 trials of any given day?
6. What evidence do you have that learning took place from day to day?
7. What evidence do you have that "forgetting" took place from day to day?
8. How can you tell (from your graph) when you have really mastered the maze?

XI. **Extension**
1. Construct new mazes with fewer or more choices and attempt to correlate learning to difficulty of the maze.
2. Allow student to leave a trail (pencil line) on the maze. Then determine by what factor the times improve. Discuss whether or not this would be considered "trial and error learning."
3. After all discussion, assign a written story requiring the student to write about all interpretations he/she could make from the graph.

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Graph = Feet - EE

I. **Topic Area**

Graphing Skills, Metric Measurement

II. **Introductory Statement**

In this beginning graphing activity, students will trace their foot on a piece of construction paper, measure the overall length of their foot "cut-out" in centimeters, and will help to construct a bar graph using the cut-outs of all the students in class. The activity provides a good opportunity for the teacher to discuss the parts of a graph, and beginning graphing concepts.

III. **Math Skills**

a. Graphing
b. Metric Measurement

Science Processes

a. Interpreting Data
b. Measurement
c. Predicting

IV. **Materials**

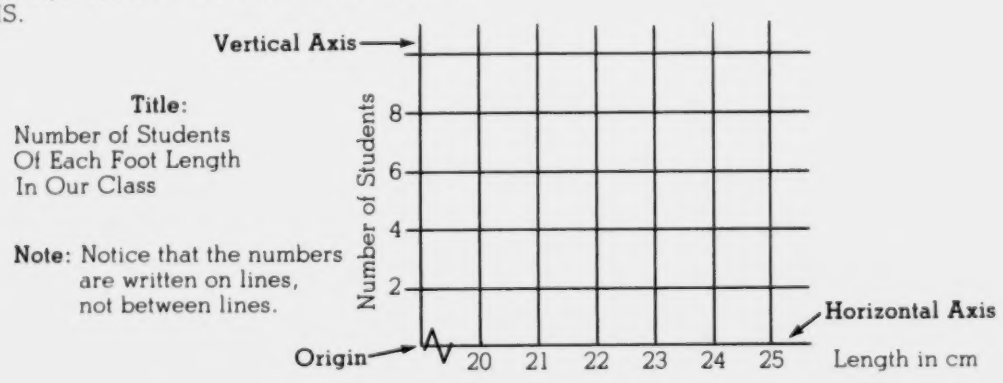
Construction Paper
Scissors
Metric Rulers
Masking Tape
Index Cards
Student Worksheet, page 43

V. **Key Question**

"What foot length is the most common in our class?"

VI. **Background Information**

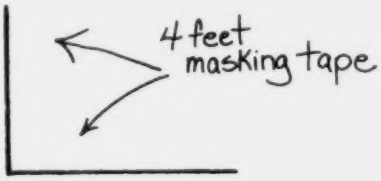
1. A GRAPH is a diagram that shows numerical relationships.
2. A graph always has four main parts: a TITLE, an ORIGIN, a VERTICAL AXIS, and a HORIZONTAL AXIS.



3. Notice that each axis is labeled and marked off in a number scale.
4. In numbering the axes on a graph, two rules must be followed. First, the numbers assigned to an axis must change equally from one line to the next (example: 2, 4, 6, 8, on the vertical axis all increase by two). And second, the range of numbers on an axis must be large enough to include the largest value you have to represent on that axis (example: If a student's foot is larger than 25 cm, the horizontal axis in the above graph would have to be extended). Note: All numbers are placed on lines, not between lines!

VII. **Management Suggestions**

1. This activity requires a large, clear wall approximately 6 feet by 6 feet on which to construct a graph. Outside building walls work very well. It is possible, however, to do this inside on a wall or chalkboard.
2. If taking students outside, it would be best to have the wall prepared beforehand with a vertical and horizontal axis. You can use masking tape to do this:



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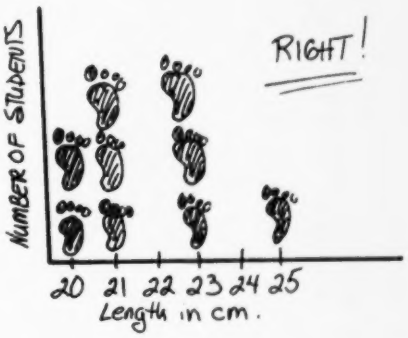
3. The day before you do this activity, you may want to warn students to wear clean socks on the following day, as they will have to take off their shoes to trace their feet.
4. TIME ESTIMATE: One 45 minute class period.

VIII. **Procedure**

1. In the classroom, have students remove a shoe and trace their foot on a piece of construction paper. You may wish to give boys and girls a different color paper so that a visual comparison between boys' feet and girls' feet can be made.
2. Next, students are to cut out this foot print, predict its overall length to the nearest centimeter, and then measure accurately.
3. This length must be written somewhere near the center of the footprint.
4. The students then take their footprints to a wall that the teacher has previously prepared with a masking tape graph.
5. A brief discussion of the main components of a graph, and basic graphing concepts should be initiated by the teacher.
6. Then, the teacher should ask the key question: WHAT FOOT LENGTH IS MOST COMMON IN OUR CLASS? Perhaps a graph can help to answer this question.
7. The teacher then asks: "Who feels that their foot is the smallest?" The smallest footprint can then be taped to the graph in the position below:

If more than one student has this length footprint, the footprints are taped in a vertical line like this:

8. Larger sizes are then taped next to the smaller ones. Be sure that if a certain length is not represented in your class, a space is left on the horizontal axis such that the numbering always increases by the same amount:



9. Continue until all footprints have been taped to the wall. Then tape index cards to the wall that label each axis. One should read "Number of Students"; the other should read "Length in cm." Likewise, cards should be used to label the numbers on each axis.
10. Review the discussion questions, and then have students reproduce the wall graph on graphing paper. (Student Worksheet, p. 43).

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IX. **What the Students Will Do**

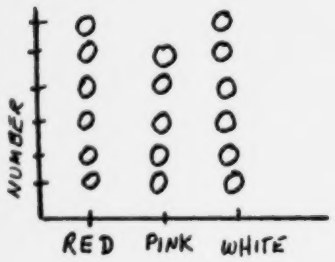
1. Trace their footprint on construction paper, and predict its length in centimeters.
2. Measure the footprint to the nearest centimeter.
3. Place their footprint in the appropriate place on the wall graph (with teacher assistance).
4. Reproduce the class wall graph on graphing paper.

X. **Discussion**

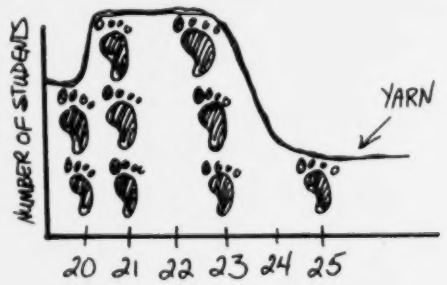
1. What does the vertical axis (on the wall) represent? (NUMBER OF STUDENTS)
2. What does the horizontal axis represent? (LENGTH OF THE FOOTPRINT IN CM)
3. Which footprint length is the most common? (ANSWER FOUND BY LOOKING AT THE GRAPH).
4. Which footprint length is the least common? (ANSWER FOUND BY LOOKING AT THE GRAPH).
5. Can you make any generalizations, or do you notice any trends on this graph? (USUALLY, THERE ARE ABOUT AS MANY VERY SMALL SIZES AS VERY LARGE SIZES, ALSO MOST FOOTPRINTS WILL BE FOUND SOMEWHERE IN THE MIDDLE OF THE GRAPH, FEW ARE AT THE EXTREME ENDS.)
6. Try to discuss with students the concept that graphs make data easier to analyze. It is easy to see which foot length is most common because it will have the tallest bar on the graph.

XI. **Extension**

1. Fill a large mouth gallon jar (or even a large plastic bag) with 3 different colors of dried beans (red, white, and pink). Have students use a spoon or fork to pick up as many beans as they can. Then line the beans up by color, and construct a BEAN GRAPH.



2. If available, use CENTICUBES (centimeter cubes) and centimeter graphing paper, and do the same activity above using the cubes instead of the beans.
3. Make similar graphs of students' heights.
4. Try to correlate foot size and height.
5. Put this activity on a bulletin board display. Let students write graffiti on the cut out feet!
6. To convert the Bar Graph to a Line Graph, connect a piece of yarn to the feet:



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The Age of Cents

I. **Topic Area**

A study of the minting dates of pennies.

II. **Introductory Statement**

We will explore the minting dates of pennies in circulation and predict from a small sample to a nationwide population with a measurable degree of accuracy.

III. **Math Skills**

a. Understanding the Meaning of Population and Sampling
b. Tabulating
c. Constructing Bar Graphs
d. Forming Hypotheses
e. Inferring and Stating Probabilities
f. Percent

Science Processes

a. Collecting and Organizing Data
b. Hypothesizing
c. Describing
d. Inferring From Data
e. Identifying and Controlling Variables

IV. **Materials**

50 pennies collected from a variety of sources
Student Worksheets, pages 44-46
Colored Pencils
Graph Paper

V. **Key Question**

"What is the median minting date of pennies in circulation?"

VI. **Background Information**

Although the U.S. Mint has produced 172 billion pennies since 1959, only about 40 billion are in circulation. Currently about 14 billion pennies are minted annually. Of these 14 billion, about 5 billion pennies disappear from general circulation each year. The study of the minting dates of coins in circulation helps to provide partial answers to such questions as: What is the average life of a penny and what is the probability that a penny will stay in circulation a given number of years?

In the fall of an election year, on the basis of fewer than 1200 phone calls, pollsters predict within 4% accuracy how 80 million plus voters will vote. In the classroom, on the basis of 200 pennies, students can tell a similar story on 40 billion pennies in circulation nationwide. Students see the power of predicting from a small, carefully randomized sample to a nationwide population of pennies.

According to the best information available, the current minting date would be approximately 22 months prior to the current month. For instance, in June, 1984, the median minting date will be August, 1982. In an unprejudiced sampling, this means that half of the pennies will show minting dates of 1983 or 1984 and half will show dates prior to 1983.

VII. **Management Suggestions**

Estimated time: two 45 minute class periods.

Divide the class into groups of 4-5 students. Let each group decide how they are going to find 50-100 pennies in a way that will be a good sample. One way would be to have each student bring 10-20 pennies from home. Another would be to check with the person in charge of lunch money. A third would be to visit a store to get pennies in exchange for other coins.

VIII. **Procedure**

1. Have each group tabulate and graph the information from their collection. (See student worksheets)
2. Determine the total number of coins used by all of the groups.
3. Have each student group *predict* what the total collection of coins will be like in such things as:
   Distribution of Minting Dates
   Number Minted in 1980, 1981 or any other year
   Probability of Staying in Circulation 10 or 20 years
   Probability of Being Minted Prior to 1970, etc.
   After each has made the prediction based on its sample of pennies, have them check the prediction against the facts.
4. Have students discuss and experiment if they like, ways in which the information they have from their combined samples can be made more reliable with respect to the entire population.

IX. **What the Students Will Do**

1. Tabulate and graph the information from their sample.
2. Predict from their sample.
3. Check their predictions against the larger sample.
4. Predict from the larger sample to the population.
5. Tabulate and graph the classroom sample.

XI. **Extension**

1. Study the minting dates of nickels in circulation and compare the data with that of pennies.
2. Study the minting dates of dimes and quarters and compare the data with that of other coins.
3. Find out from the U.S. Treasury how many coins were minted in given years and how the number to be minted is determined.

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The Rubber Band STRETCH

I. **Topic Area**

Applying and Generalizing

II. **Introductory Statement**

In this investigation students will explore a cause and effect relationship with rubber bands and other common materials; specifically, they will add mass to the system illustrated on student page and measure the stretch of the rubber band for each mass added. After graphing their data, students will develop a formula relating stretch to mass added.

III. **Math Skills**

a. Measuring Length and Mass
b. Counting
c. Discovering Patterns
d. Developing a Formula
e. Applying a Formula

Science Processes

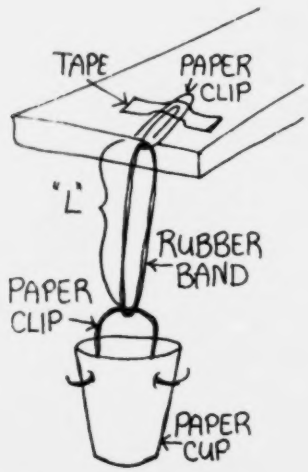
a. Measuring
b. Predicting and Estimating
c. Controlling Variables
d. Collecting and Recording Data
e. Interpreting Data
f. Applying and Generalizing

IV. **Materials**

Rubber bands 5-6 cm in diameter by 1 mm thick by 2 mm wide (or similar)
Paper cups
Large paper clips
Tape
Lots of pennies
Metric ruler
Student Worksheet, page 47

V. **Key Question**

"How much does a rubber band stretch?"



VI. **Background Information**

1. The data table and graph are set up for rubber bands of the characteristics described above.
2. Pennies are one of the least expensive kinds of masses to use in an investigation. 200 pennies will suffice for a class of 30 working in groups of 3. A few replacement pennies are recommended.
3. Pennies minted after 1981 have less mass than those minted during or before 1981. This is a very minor factor.
4. Several variables are at work in this investigation; most deal with age, size, composition, and general condition of the rubber bands, and with how many times and how much rubber bands have been stretched. Students should be allowed to discover these variables on their own.
5. At least two sources of error are possible: 1) pennies' masses vary, as pointed out above, and 2) students will not always make measurements from the same vantage point, thus causing up to ±1 mm error per measurement. By calling student attention to this and perhaps by demonstrating it, error can be reduced to ±0.5 mm per measurement... or, students can be left to discover this error on their own.
6. Mathematics convention is to put the dependent variable on the left side of the equation, i.e. $S = 1/3\,M$ where S is the dependent variable. When teaching a cause-effect relationship, however, it may add clarity if we ignore this convention and write $M = 3S$ instead of $S = 1/3M$.

VII. **Management Suggestions**

1. As a full-scale science investigation, two periods of 45 minutes each are required; as a math exercise, one period will suffice.
2. Each team has three roles: 1) ruler positioner, 2) measurement reader, and 3) mass adder/recorder.

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VIII. **Procedure**

Day One - Investigating to Collect Data

1. Put together the materials.
2. Ask key question and allow students to state their ideas.
3. The need for focusing upon a "do-able" investigation will arise. Tell students what materials are available and focus discussion.
4. Provide materials.
5. Roam to aid teams in need of direction.
6. Students who finish early should be encouraged to graph their data and to suggest reasons why their graph lines are not perfectly straight.

Day Two - Interpreting Data, Generalizing, and Applying

1. Provide instruction on graphing, as needed. Those who have finished or will finish quickly should be encouraged to run the investigation again, trying to maintain better control over variables and trying to reduce measurement error.
2. Provide large group instruction on developing formulas.
3. Suggest an application problem as a contest. "Use your team's formula to predict how much the rubber band will stretch when we add 40 pennies."

IX. **What the Students Will Do**

Day One

1. Students will participate in discussion centered on key question.
2. Students will work in teams of three to collect and record data.

Day Two

1. Students will graph data.
2. Advanced students will give consideration to the shape of their graph lines.
3. Students will participate in large group activity in which a general formula is developed to relate S (amount of stretch) to M (mass added).
4. Students will use formula to make a prediction.

X. **Discussion Questions**

Before Gathering Data

1. HOW DOES A RUBBER BAND STRETCH?
2. What are the ways a rubber band can be stretched?
3. What do you think are the important factors influencing how a rubber band stretches?
4. (NOTE: Sketch the system on the blackboard). If we were to stretch a rubber band by adding mass (weight) to a system like the one on the blackboard, what information would we need to keep track of?

After Gathering Data

1. Please tell me what you know about formulas.
2. Provide information needed for development of a general formula from the student data.
3. "Use your team's formula to predict how much the rubber band will stretch when we add 40 pennies."

XI. **Extension**

1. Compare rubber bands of different characteristics.
2. Proceed to next investigation: RUBBER BAND SHOOT

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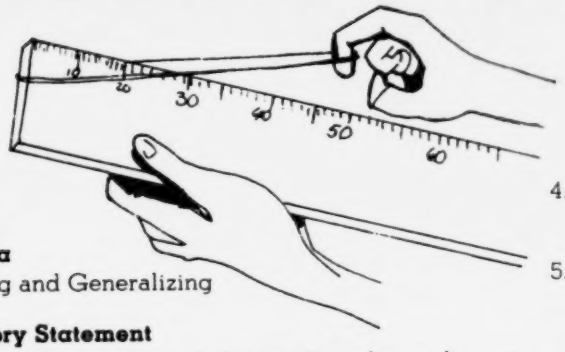
Rubber Band SHOOT!



I. **Topic Area**
Applying and Generalizing

II. **Introductory Statement**

This investigation can stand alone or it can be used as the second of two closely related investigations (see RUBBER BAND STRETCH in this booklet). In this investigation students will explore a cause and effect relationship with rubber bands; they will stretch the rubber band (cause) and measure how far it travels when released (effect). After graphing their data, students will develop a formula (using their data) which relates distance traveled to the amount of stretch.

III. **Math Skills**

a. Measuring Length and Mass
b. Counting
c. Discovering Patterns
d. Developing and Applying Formula

Science Processes

a. Measuring
b. Predicting
c. Controlling Variables
d. Gathering and Recording Data
e. Interpreting Data (Graphs)
f. Applying and Generalizing

IV. **Materials**

Rubber bands 5-6 cm in diameter by 1 mm thick by 2 mm wide (or similar)
Metric ruler
Meter stick or metric measuring tape
Student Worksheet, page 48

V. **Key Question**

"How does a rubber band shoot?"

VI. **Background Information**

The data table and graph are set up for rubber bands of the characteristics described above.

Several variables are at work in this investigation; most deal with the characteristics of the rubber band and with shooting techniques.

VII. **Management Suggestions**

1. This investigation may precede, follow, or replace RUBBER BAND STRETCH as a generalizing and applying exercise.
2. One full 45 minute period is required for this investigation.
3. Teacher should test a rubber band prior to class to see how much stretch results in the maximum safe distance traveled.
4. Class should be rearranged so that each team of two students has a clear firing range about 3 meters long.
5. Class should be informed of the maximum stretch allowed and the need to insure that rubber bands do not fly beyond the limits of the firing ranges.

VIII. **Procedure**

1. Begin class by playing with a rubber band.
2. Ask students the key question.
3. Accept ideas.
4. Provide materials.
5. Monitor for safety.
6. Provide instruction regarding developing a formula.

IX. **What the Student Will Do**

1. Students will participate in discussion centered on key question.
2. Students will work in teams of three to collect and record data.
3. To gather data student teams will stretch a rubber band by a measured amount, release it downrange, and measure the distance traveled.
4. Students will stay within the maximum safe stretch limit imposed by the teacher.
5. Students will graph data and verbalize the general relationship between stretch and distance.
6. Students will participate in a discussion which narrows the general relationship to symbols and numbers (from their own data).

X. **Discussion Questions**

Discussion before the activity should focus on achieving consensus as to the meaning of the key question, the design of the investigation, and the need to investigate safely.

Discussion after the activity may focus on relating this investigation to the RUBBER BAND STRETCH, or on dealing with the variables which were discovered during the investigation.

XI. **Extension**

1. Compare the behavior of rubber bands of different characteristics.
2. Devise a formula which combines the formula developed in this investigation with the formula developed in RUBBER BAND STRETCH, and then use the new formula to predict how far a rubber band would shoot if the equivalent of X g were applied to stretch the rubber band. This would provide a door through which students could enter the realm of weight, gravity, and forces in general.

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IT'S BEAN FUN!

I. Topic Area

Sampling

II. Introductory Statement

The concept of sampling and ratios will be explored in this investigation. By sampling jars full of 3 different colored beans, students will determine the color ratio of the beans in each jar.

III. Math Skills

a. Statistics/Probability
b. Ratio
c. Problem Solving
d. Logic
e. Averaging

Science Processes

a. Interpreting Data
b. Applying/Generalizing

IV. Materials (per class)

5 large mouth gallon jars (if unavailable, large plastic bags will work).
3 different colored dried beans (pink, red, and white), 4 lb. bag of each color
1/4 cup measuring cup
5 tablespoons
Student Worksheet, pages 49-50

V. Key Question

"Can you determine the color ratio of the beans in each jar?"

VI. Background Information

1. ***RATIO:*** A comparison of two numbers by division. For example, the ratio of 4 to 6 can be written 4/6, 4 ÷ 6, 4:6, or 4 to 6.
2. ***VOLUME:*** The amount of space a material occupies, or takes up.
3. ***COLOR RATIO:*** Color ratio is the number of pink beans and red beans to white beans in the jar. It is found by taking several samples of equal volume and comparing the numbers of each color bean counted. Example:

Count

Sample	Red	Pink	White
1	10	12	2
2	5	11	4
3	9	15	1
4	12	12	1
Total	36	50	8

	Red		Pink		White
Therefore, the color ratio =	36	:	50	:	8
Divide each by 8 to get	4.5	:	6.2	:	1

Note that the white beans are the least in number. Therefore, we divide each ratio by the smallest number to calculate ratios to 1. Therefore there are 4.5 times as many red beans as white beans, and 6.2 times as many pink beans as white beans in this jar.

The color ratio is established by the teacher when each jar is initially filled.

4. ***VOLUME RATIO:*** The volume ratio is defined as the ratio of the volume of each of the beans in the jar. Because the beans are of different size, an equal number of each color bean will result in different volumes. The volume ratio is established by the teacher when the jars are initially filled.
5. When sampling the jars, each student must use a uniform sampling device. If using a tablespoon, *all* students must use the same kind and size spoon.
6. Make sure that before a student samples from a jar, all the beans taken out in a previous sample have been RETURNED TO THE JAR, and the sample has been stirred.

VII. Management Suggestions

1. Estimated time: two 45 minute class periods.
2. Try to use at least one bean that is much larger than the other two beans.
3. You may choose to set up fewer or more jars. Five is suggested if this is to be a total class activity. Student groups can then rotate through and sample each jar. This activity can work with only one jar, but other arrangements will have to be made for those students not actively sampling.
4. ***TO FILL THE JARS:**** Fill up a 1/4 cup measuring cup and count how many of each type of bean it takes to fill the 1/4 cup. (For accuracy, you may wish to take 3 samples of each color bean, and find an average number). Once you know how many beans it takes to fill the cup, simply count the number of cup-fulls of each bean that you put in the jar. Example:

	White Lima	Red Bean	Pink Bean
1/4 cup =	39	151	175

By putting 5 - ¼ cups of each color in a jar you will have:

39 × 5 = 195 White Lima Beans
151 × 5 = 755 Red Beans
175 × 5 = 875 Pink Beans

Thus, your color ratio will be:	195	:	755	:	875 or
(Divide by 195)	1	:	3.8	:	4.5 or
Approximately	1	:	4	:	4

Because you used the same volume for each color bean (5-1/4 cups), the volume ratio is 1 : 1 : 1.

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5. The other jars can be filled with different numbers of each color by varying the number of 1/4 cups used to fill the jar. This will change the color ratio and the volume ratio. Try these combinations:

Number of 1/4 Cups			Volume Ratio			Color Ratio		
White	Red	Pink	White	Red	Pink	White	Red	Pink
6	3	3	2	1	1			
2	4	2	1	2	1			
2	2	6	1	1	3			
1	6	3	1	6	3			
4	8	2	2	4	1			

6. Each jar that students sample should have different bean color ratios.
7. Averages and ratios *should not* be calculated by the student until all jars have been sampled. The teacher may choose to do these calculations as a large group activity.
8. After students have calculated their ratios for each jar, the teacher should place the true color ratios on the board without identifying which ratios belong to each jar. In this way, students can compare their results with the known values, and match their values to the known ones.
9. Student Worksheet, p. 50 has been provided in the event that beans other than white, pink, and red are used.

VIII. **Procedure**

1. Discuss the concept of color ratio with the students.
2. Place the jars around the room at different locations.
3. Divide the class into as many groups as you have jars. There should be no more than 6 students to a group. Each group will complete all the data for their jar and when finished will move to another jar. Students will continue sampling and recording data until all the data for all jars is completed.
4. Students will sample a jar as follows:
   a. Using a fork or spoon, the student will pick up as many beans as possible, and place them on the table.
   b. The beans will be separated by color, and each color will be counted and recorded in the data table under "SAMPLE 1".
   c. All beans will then be returned to the jar and a second sample will be taken, counted, and recorded under "SAMPLE 2".
   d. Finally, a third sample will be taken in the same way.
   e. Ratios and averages *should not* be done by students until all jars have been sampled.
5. When all sampling is completed, averages and ratios can be determined, and the Student Worksheet completed. Then, the student ratios can be compared to the known values.

IX. **What the Students Will Do**

1. Sample beans from jars by counting and recording the numbers of each color bean.
2. Find the average number of each color in a sample for each of the jars.
3. Calculate the color ratio of the beans in each of the jars.

X. **Discussion**

1. Besides the color ratio, what other ratios could be calculated by sampling the beans? (Volume ratio; Broken to Unbroken beans)
2. How could we measure the volume ratio of the beans in a jar? (Use a standard unit of volume, such as a small pill bottle. Take 2 or 3 large samples of the beans, and then fill the pill bottles with separate color beans. The number of full bottles of each color will represent the volume ratios; OR use a graduated cylinder to find the volume of each color taken from several samples).
3. What variables might have affected the outcome of the color ratio experiment? (Size of the beans; Steady hands of the samplers)
4. What real world ratios could be studied? (Ratio of unemployed to employed people; Ratio of number correct on a test to total number of problems; Ratio of cost to benefit; Ratio of increased wages to increased buying power; Ratio of hits to at bats)

XI. **Extension**

1. Try using jelly beans instead of dry beans. Test to see if using a uniform size (jelly bean) changes the accuracy of student results.
2. Try graphing the average number of each color bean in each jar. Do this on one piece of graph paper.
3. Estimate the total number of beans in one jar—closest to the correct number gets a prize! Have students sample the jar to determine the actual number.
4. Sample and calculate the volume ratios for the jars.
5. Try using a different sampling device (fork, measuring spoon, etc.)
6. Tell students the actual number of scoopfuls of beans in a jar. Have students predict and determine the total number of scoopfuls for each color bean.
7. Try converting ratios to percents.
8. Calculate the percentage error for estimates of total number of beans in the jar, and/or color ratios.

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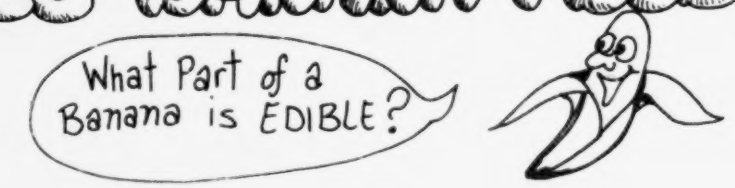
THE BIG BANANA PEEL!



I. **Topic Area**

Estimating, measuring and generalizing.

II. **Introductory Statement**

In this investigation the students will determine what percentage of a banana is edible. By sampling several bananas, the students will develop a formula relating the edible part to the total mass of the banana.

III. **Math Skills**

a. Finding Mass
b. Using Ratios
c. Finding Percentages
d. Graphing
e. Writing a Formula
f. Averaging

Science Processes

a. Measuring
b. Recording Data
c. Interpreting Data
d. Generalizing

IV. **Materials (per class)**

A supply of bananas
Scales with masses
Student Worksheet, page 51

V. **Key Question**

"What part of a banana is edible?"

VI. **Background Information**

1. This may be the students' first experience in writing a formula. If so, the development of a formula needs to be discussed. In this case, the edible part of a banana (E in the formula) is to be expressed as a fraction or percentage of the total mass of the banana (T in the formula). Thus, if one-half of the banana is edible, the formula would be $E = 1/2T$. Most bananas will come very close to fitting the formula $E = .65T$ or $E = 2/3T$.
2. If desired, the average or the median percentage may be used. If either term is used, introduce the students to the term being employed.

VII. **Management Suggestions**

1. Before students begin, have them predict and record the edible percentage of a banana.
2. Students may work in groups of five with each member of each group having one banana and actually carrying out all of the activities. The members in a group would then pool their information.
3. Estimated time: one or two 45 minute periods.

IX. **What the Students Will Do**

1. Predict the percentage of a banana that is edible.
2. Measure the mass of the unpeeled and peeled banana and record the results.
3. Find the ratio of the edible part to the total mass.
4. Find the percentage that is edible.
5. Graph the percentage that is edible.
6. Graph the results of other members of the group.
7. Write the formula for the edible portion.

XI. **Extension**

This may lead to finding edible portions of other foods such as fruits, steaks, etc. The cost per kilogram or gram of the edible portion could be computed.

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IT'S A SHOE-IN!

1.

2.

3.

4.

5.

6.

Unique U

Unique U

STUDENTS

GIRLS

LONG HAIR

TALL

SHORT

SHORT HAIR

TALL

SHORT

BOYS

LONG HAIR

TALL

SHORT

SHORT HAIR

TALL

SHORT

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NAME _____

On Your Own Two Feet

SHOE NUMBER	HAS LACES	SEPARATE HEEL	MATERIAL OF SOLE	MATERIAL OF SHOE	NUMBER OF HOLES	NUMBER OF COLORS	MAIN COLOR	LACE COLOR	SHOE TYPE	SIZE
#										
#										
#										
#										
#										
#										
#										
#										
#										
#										
#										
#										

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NAME _____

On Your Own Two Feet

SHOE TYPE	TOTAL NUMBER OF TYPE	÷	TOTAL NUMBER OF SHOES IN CLASS	x 100 =	PER CENT OF EACH TYPE
_____	_____	÷	_____	x 100 =	_____
_____	_____	÷	_____	x 100 =	_____
_____	_____	÷	_____	x 100 =	_____
_____	_____	÷	_____	x 100 =	_____
_____	_____	÷	_____	x 100 =	_____
_____	_____	÷	_____	x 100 =	_____
_____	_____	÷	_____	x 100 =	_____

TOTAL NUMBER WITH HEEL _____ ÷ TOTAL NUMBER OF SHOES IN CLASS _____ x 100 = PER CENT WITH HEEL _____

TOTAL NUMBER WITH LACES _____ ÷ TOTAL NUMBER OF SHOES IN CLASS _____ x 100 = PER CENT WITH LACES _____

NOW, GRAPH THE SHOE SIZES IN YOUR CLASS

NUMBER

SHOE SIZES

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NAME

Sorting All Sorts

Rules	Letters

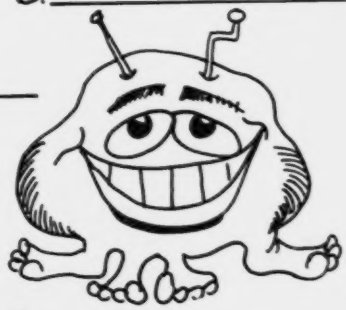
NAME _____

Creature's Features

A. _____

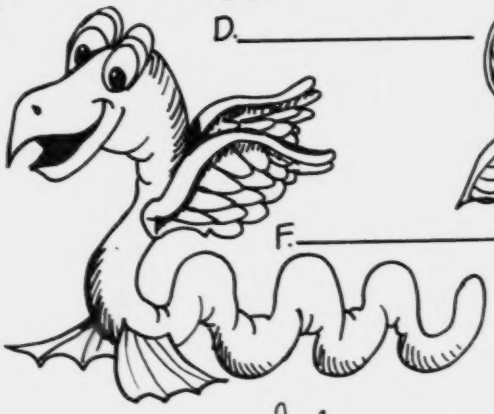
B. _____

C. _____



D. _____

E. _____



F. _____

G. _____

H. _____

I. _____

J. _____

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Creature's Features

Rules	Letters

Dichotomous Key

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NAME _____

SUPER SLEUTH

STEPS TO SOLVING THE MYSTERY

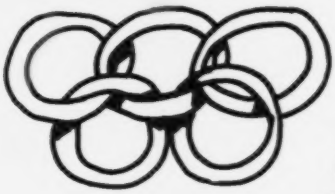
1. Place 4-5 gr of any powder in an empty cup.
2. Put pinch of powder in the other cup. Add 1 drop of vinegar. Record the reaction.
3. Clean cup and repeat the procedure using iodine instead of vinegar. Record reaction.
4. Heat remaining sample on aluminum foil. Record reaction.
5. Sketch the powder.

POWDER NUMBER	VINEGAR TEST	IODINE TEST	HEAT TEST	DRAWING OF POWDER
1				
2				
3				
4				
5				
6				
7				
MYSTERY MIXTURE				

THE POWDER NUMBERS FOUND IN MY MYSTERY MIXTURE ARE:

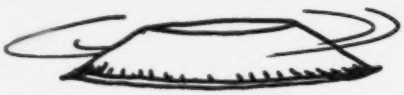
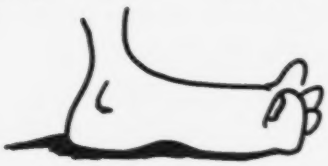
_____ _____ _____ _____ _____ _____

MINI-METRIC OLYMPICS

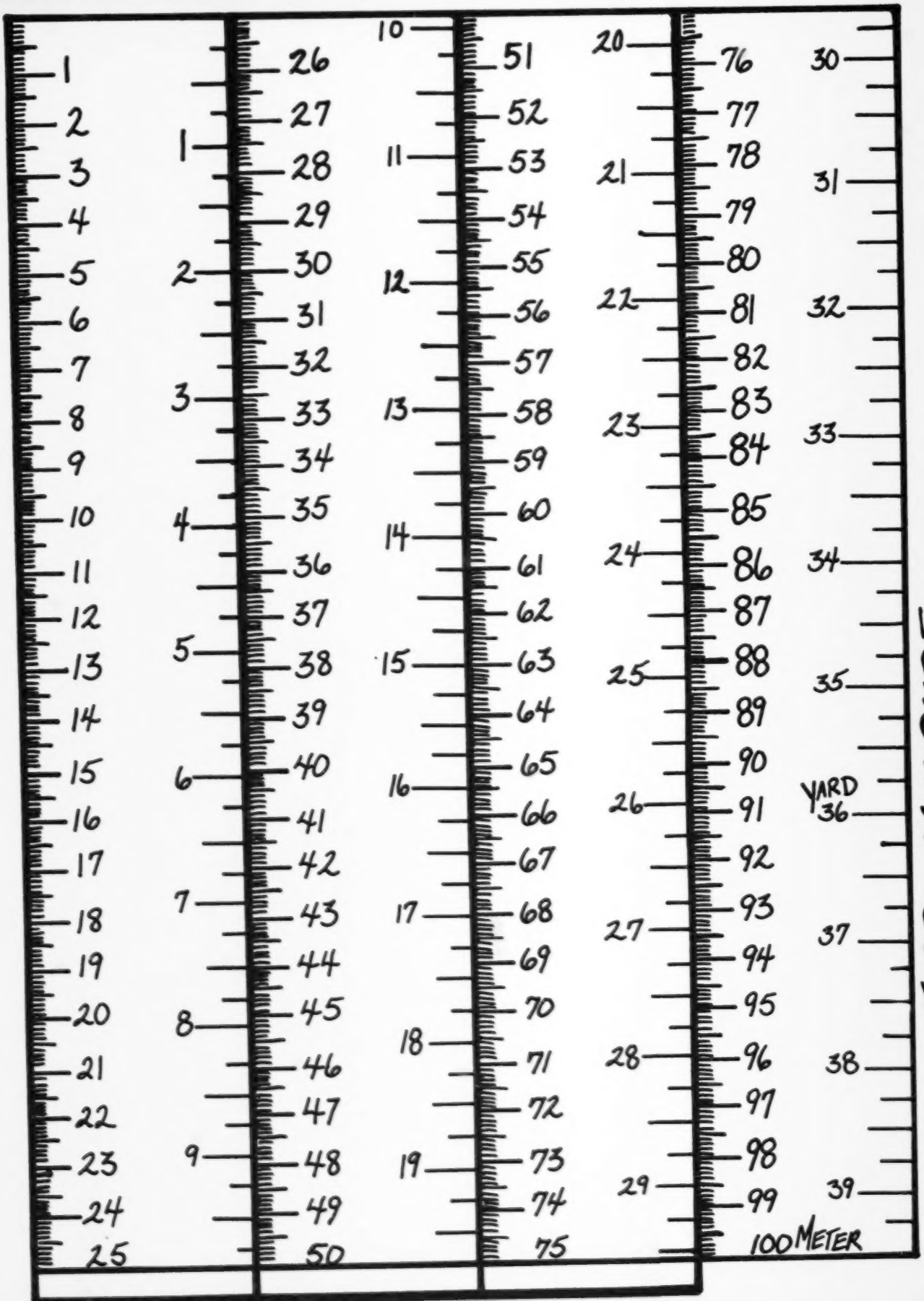


COMPETITOR _____

TEAM CAPTAIN _____

EVENT	ESTIMATE	ACTUAL	SCORE (DIFFERENCE)
1. PAPER PLATE DISCUS 	_____ cm	_____ cm	_____
2. PAPER STRAW JAVELIN	_____ cm	_____ cm	_____
3. COTTON BALL SHOT PUT	_____ cm	_____ cm	_____
4. RIGHT HANDED MARBLE GRAB	_____ g	_____ g	_____
5. LEFT-HANDED SPONGE SQUEEZE	_____ ml	_____ ml	_____
6. BIG FOOT CONTEST 	_____ cm^2	_____ cm^2	_____

TOTAL _____


TAPE MEASURE
YARD
36
100 METER

PAPER STRAW JAVELIN THROW

1. Estimate the distance (in cm) that you think you can throw the "javelin". Record.

2. Place feet on starting line. Throw "javelin". (One throw only.)

3. Measure distance from starting line to the position of the "javelin." Record on score sheet.

MINI-METRIC OLYMPICS
TASK CARD

PAPER PLATE DISCUS

1. Estimate the distance (in cm) that you think you can throw the discus. Record on score sheet.

2. Place feet on starting line. (masking tape on floor) Throw the "discus". (one throw only) Measure distance from starting line to the position of the paper plate. Record on score sheet.

MINI-METRIC OLYMPICS
TASK CARD

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COTTON BALL SHOT PUT

1. Estimate the distance (in cm) that you think you can throw the "shot". Record.

2. Place feet on starting line. Throw the "cotton ball shot". (One throw only.) Measure distance from starting line to the position of the cotton ball. Record.

MINI-METRIC OLYMPICS
TASK CARD

RIGHT-HANDED MARBLE GRAB

1. Estimate (in grams) the amount of marbles you can grab in your right hand. Record.

2. With right hand only, grab a fistful of marbles from the container. Weigh on a balance scale. Record.

MINI-METRIC OLYMPICS
TASK CARD

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LEFT-HANDED SPONGE SQUEEZE

1. Have sponge soaking in large bucket of water. Observe.

2. Estimate the amount of water (in ml) that you think you can squeeze out of the sponge (one squeeze only!) Record.

3. Squeeze sponge into separate container. (marked liter). Measure water "squeezed". Record.

MINI-METRIC OLYMPICS
TASK CARD

BIG FOOT WAS HERE!

1. Estimate in square cm the area of your foot print. Record.

2. Remove one shoe. Trace around your foot on square centimeter graph paper. Figure the area. Record.

3. Cut out your foot print. Sign your name and area. Post on the bulletin board.

MINI-METRIC OLYMPICS
TASK CARD

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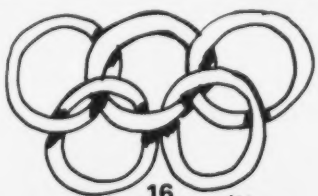
NAME _____

Mini Metric Olympics II

$\frac{\text{Error}}{\text{Actual}} \times 100 = \%\text{ of Error}$

	EVENT	ESTIMATE	ACTUAL	ERROR	% ERROR	SCORE
LENGTH	1. HAND SPAN	mm				
	2. ARM SPAN (tip to tip)	cm				
	3. STEADY STRIDE	cm				
MASS	1. WALLET	g				
	2. PENCIL	g				
	3. PERSONAL ITEM (FREE CHOICE)	g				
	4. BODY WEIGHT	Kg				
VOLUME	1. PEN CAP	ml				
	2. PAPER CUP	ml				
	3. YOUR FIST	ml				
	4. BLOCK OF WOOD	ml				
AREA	1. SHEET OF PAPER	cm^2				
	2. CLASSROOM CEILING	cm^2				
	3. FOOTBALL FIELD	m^2				
	4. DESK TOP	cm^2				



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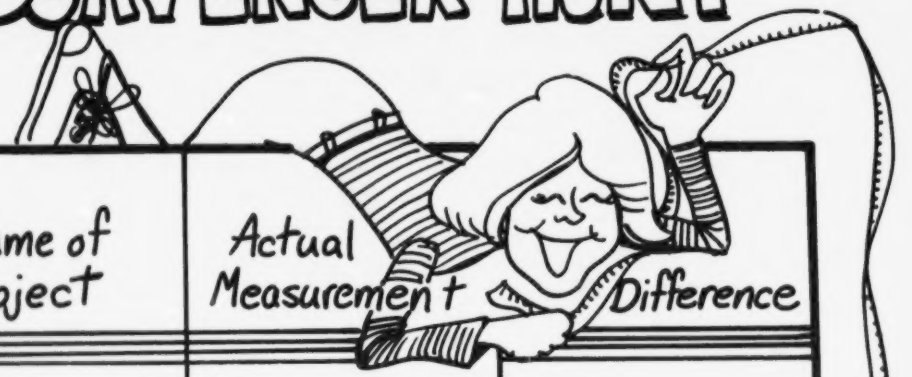
METRIC SCAVENGER HUNT



Try to find objects of these lengths	Name of Object	Actual Measurement	Difference
1. 40 cm			
2. 87 cm			
3. 3 cm			
4. 1 m			
5. 31 cm			
6. 1.5 m			
7. 65 mm			
8. 240 mm			
9. 28 cm			
10. 2 mm			
		Total Differences	

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Name _____

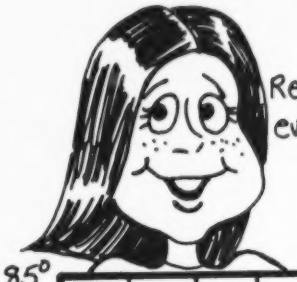
COOL IT!

Which container will retain its heat the longest? _____

TEMPERATURE RECORD

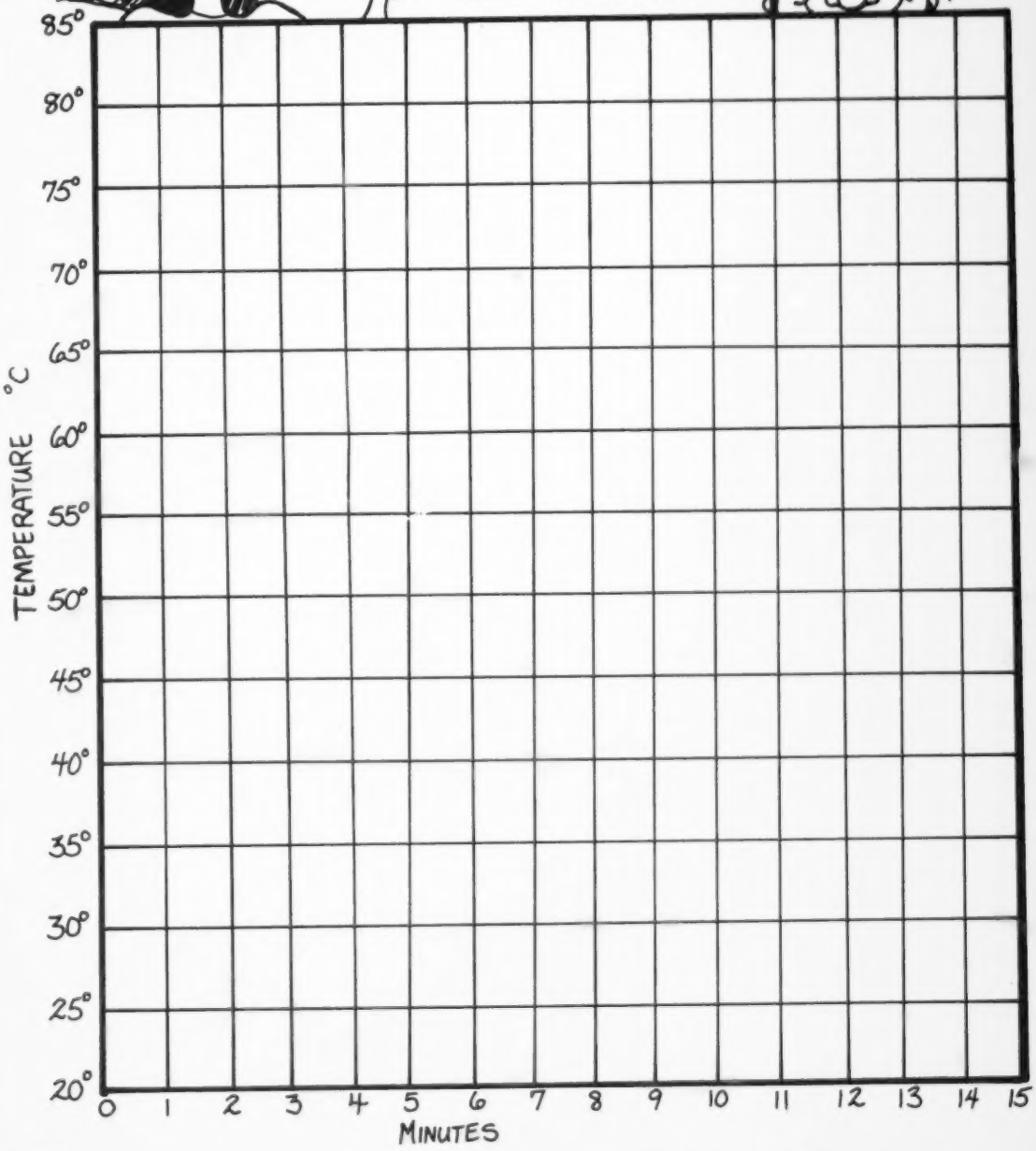
TIME IN MINUTES	STYROFOAM CUP	TIN CAN
STARTING TEMP.		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Start recording temperatures as soon as the thermometers stop rising.



Record the temperatures every minute for 15 minutes.

Make a line graph to show the rate of cooling for each container.



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NAME _____

HOT STUFF

As soon as the water temperature reaches 70°C, Record the temperature every minute for 15 minutes.

Insulator	TIME IN MINUTES														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

1. Pick an insulator.
2. Put 1 inch in bottom of outside container.
3. Set Aluminum Can on insulator and center it in outside container.
4. Pack remaining space with the same insulation
5. Put 300 ml of 75°C water in aluminum can
6. As soon as the water reaches 70°C, start the timer.

Aluminum Can

Outside Container

Insulator List

sawdust cotton
shredded paper
vermicalite
fiberglass
sand foam
air plastic

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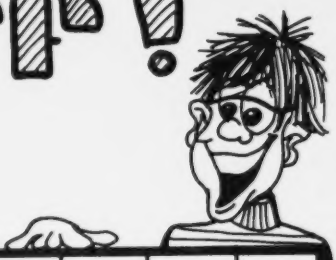
NAME _____

HOT STUFF!



70°C

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

MINUTES

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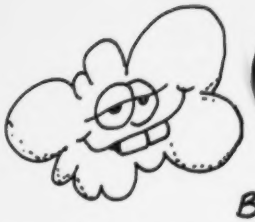
NAME _____



Corny Comparison

BRAND A. _____ BRAND B. _____

ml corn	70	100	130	160
ml oil	20	30	40	50
ESTIMATED VOLUME POPPED CORN				
ACTUAL VOLUME				
RATIO OF THE VOLUME OF $\frac{\text{POPPED}}{\text{UNPOPPED}}$				

ml corn	70	100	130	160
ml oil	20	30	40	50
ESTIMATED VOLUME POPPED CORN				
ACTUAL VOLUME				
RATIO OF THE VOLUME OF $\frac{\text{POPPED}}{\text{UNPOPPED}}$				

Please compare the amount of popped corn to unpopped corn. About how many times did the volume of unpopped popcorn expand when popped? _____

_____

Please write a sentence to explain what you discovered.

_____

_____

_____

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NAME _____

Weight Watchers

1. LOOK AT THE 6 ITEMS. LIST THEM IN ORDER FROM HEAVIEST TO LIGHTEST.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

2. NOW ESTIMATE THEIR MASS (grams)
3. WEIGH AND FIND THEIR ACTUAL MASS
4. DETERMINE THE ERROR OF YOUR GUESS
5. FIND THE RATIO
6. COMPUTE THE PER CENT OF ERROR

ITEM	ESTIMATED MASS IN GRAMS	ACTUAL MASS IN GRAMS	ERROR (DIFFERENCE)	RATIO: DIFFERENCE / ACTUAL	DECIMAL DIFF. ÷ ACTUAL	PER CENT OF ERROR DECIMAL X 100
GOLF BALL						
MARBLE						
WOODEN BLOCK						
TENNIS BALL						
PING PONG BALL						
CLAY BALL						
		AVERAGE ERROR			AVERAGE PER CENT OF ERROR	

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NAME _____

Weight Watchers

Sketch the 6 objects →

1. LOOK AT 6 ITEMS. LIST THEM IN ORDER FROM HEAVIEST TO LIGHTEST.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

2. NOW ESTIMATE THEIR MASS (grams).
3. WEIGH AND FIND THEIR ACTUAL MASS.
4. DETERMINE THE ERROR OF YOUR GUESS.
5. FIND THE RATIO.
6. COMPUTE THE PER CENT OF ERROR.

ITEM	ESTIMATED MASS IN GRAMS	ACTUAL MASS IN GRAMS	ERROR (DIFFERENCE)	RATIO: $\frac{\text{DIFFERENCE}}{\text{ACTUAL}}$	DECIMAL DIFF. ÷ ACTUAL	PER CENT OF ERROR DECIMAL X 100
		AVERAGE ERROR			AVERAGE PER CENT OF ERROR	

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SECOND GUESSING

TRIAL NUMBER	TIME PERIOD (SECONDS)	TIME ESTIMATE (ACTUAL SECONDS)	ERROR OF ESTIMATE	RATIO (ERROR / TIME PERIOD)	DECIMAL (ERROR ÷ TIME PERIOD)	% of ERROR (DECIMAL X 100)

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NAME _____

Chaotic Computing!

TABLE 1

SET A (WITHOUT DISTRACTION)

TIME BEGUN	TIME FINISHED	TIME TAKEN	NUMBER CORRECT

TABLE 2

SET B (WITH DISTRACTON)

TIME BEGUN	TIME FINISHED	TIME TAKEN	NUMBER CORRECT

10	17
3	15
5	8
8	15
6	6
9	18
1	9
4	11
7	1
2	13
12	4
20	19
17	4
15	14
14	6
18	13
13	2
16	19
19	30
2	45
12	7
5	3
20	1
3	13
7	6

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Set B (Level 1)

Chaotic Computing!

5 +8	11 −4	137 −49	135 +87
8 −6	321 −57	5 +27	748 +77
69 +32	424 +386	145 −126	17 −9
13 +97	403 −304	573 −477	7977 +8744
5273 −3827	62,785 −38,068	142,348 +161,764	557,863 −456,954

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Set A (Level 1)

Chaotic Computing!

12 −3	152 −74	8 +7	193 +89
231 −78	837 +68	4 −1	29 +3
127 −108	58 +43	473 +237	13 −7
743 −648	302 −203	48 +9	8723 +7999
6382 −4525	71,523 −42,634	174,875 +131,239	573,641 −472,732

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Set B (Level 2)

Chaotic Computing!

$$\begin{array}{r} 8 \\ \times 9 \\ \hline \end{array}$$

$54 \div 9 =$

$$\begin{array}{r} 6 \\ \times 7 \\ \hline \end{array}$$

$24 \div 8 =$

$$\begin{array}{r} 32 \\ \times 4 \\ \hline \end{array}$$

$$\begin{array}{r} 831 \\ \times 6 \\ \hline \end{array}$$

$6\overline{)436}$

$4200 \div 60 =$

$$\begin{array}{r} 236 \\ \times 9 \\ \hline \end{array}$$

$$\begin{array}{r} 903 \\ \times 5 \\ \hline \end{array}$$

$5\overline{)203}$

$9600 \div 10 =$

$$\begin{array}{r} 396 \\ \times 32 \\ \hline \end{array}$$

$$\begin{array}{r} 765 \\ \times 29 \\ \hline \end{array}$$

$$\begin{array}{r} 308 \\ \times 13 \\ \hline \end{array}$$

$23\overline{)7635}$

$$\begin{array}{r} 306 \\ \times 604 \\ \hline \end{array}$$

$$\begin{array}{r} 813 \\ \times 134 \\ \hline \end{array}$$

$$\begin{array}{r} 496 \\ \times 109 \\ \hline \end{array}$$

$$\begin{array}{r} 6934 \\ \times 943 \\ \hline \end{array}$$

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Set A (Level 2)

Chaotic Computing!

$$\begin{array}{r} 9 \\ \times 5 \\ \hline \end{array}$$

$42 \div 7 =$

$$\begin{array}{r} 3 \\ \times 8 \\ \hline \end{array}$$

$72 \div 8 =$

$$\begin{array}{r} 42 \\ \times 3 \\ \hline \end{array}$$

$$\begin{array}{r} 613 \\ \times 8 \\ \hline \end{array}$$

$8\overline{)493}$

$3500 \div 70 =$

$$\begin{array}{r} 623 \\ \times 9 \\ \hline \end{array}$$

$$\begin{array}{r} 309 \\ \times 5 \\ \hline \end{array}$$

$5\overline{)302}$

$4500 \div 100 =$

$$\begin{array}{r} 693 \\ \times 23 \\ \hline \end{array}$$

$$\begin{array}{r} 576 \\ \times 92 \\ \hline \end{array}$$

$$\begin{array}{r} 803 \\ \times 31 \\ \hline \end{array}$$

$32\overline{)6735}$

$$\begin{array}{r} 406 \\ \times 603 \\ \hline \end{array}$$

$$\begin{array}{r} 314 \\ \times 138 \\ \hline \end{array}$$

$$\begin{array}{r} 964 \\ \times 901 \\ \hline \end{array}$$

$$\begin{array}{r} 3964 \\ \times 349 \\ \hline \end{array}$$

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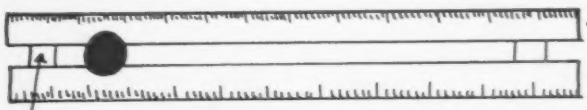
name _____

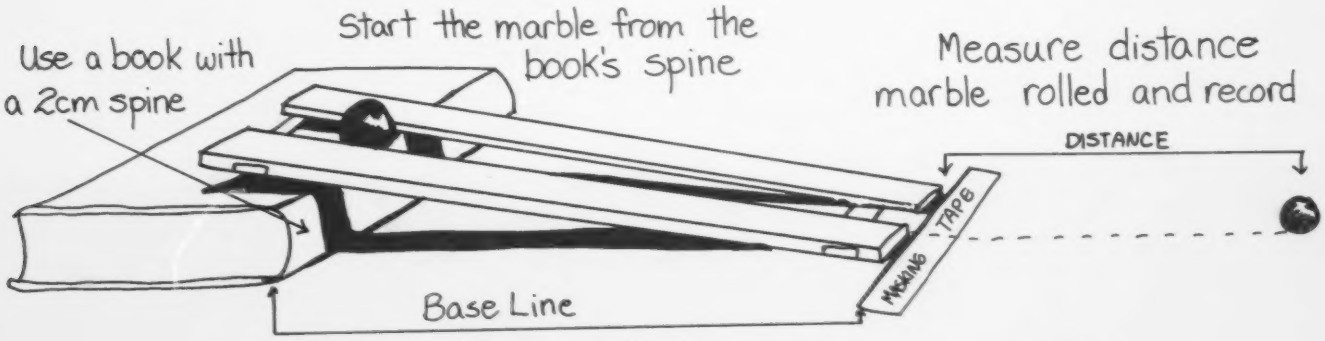
"It's Simply Marbleous"

Height	2 cm	4 cm	8 cm	16 cm	32 cm
Trial #1					
Trial # 2					
Trial # 3					
Trial # 4					
Trial # 5					
Total					
Average					

DISTANCE MARBLE ROLLED IN CM

Construct a ramp for the marble




Use a book with a 2cm spine
Start the marble from the book's spine
Measure distance marble rolled and record
DISTANCE
MASKING TAPE
Base Line
Mark and Keep Base Line at 88cm

How does the slope of the ramp affect the distance a marble will roll?

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name _____

"It's Simply Marbleous"

Distance the marble rolls

(cm)

300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

2cm 4cm 8cm 16cm 32cm

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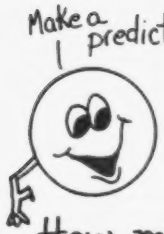
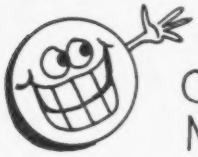
NAMES _____

M&M's Count & Crunch



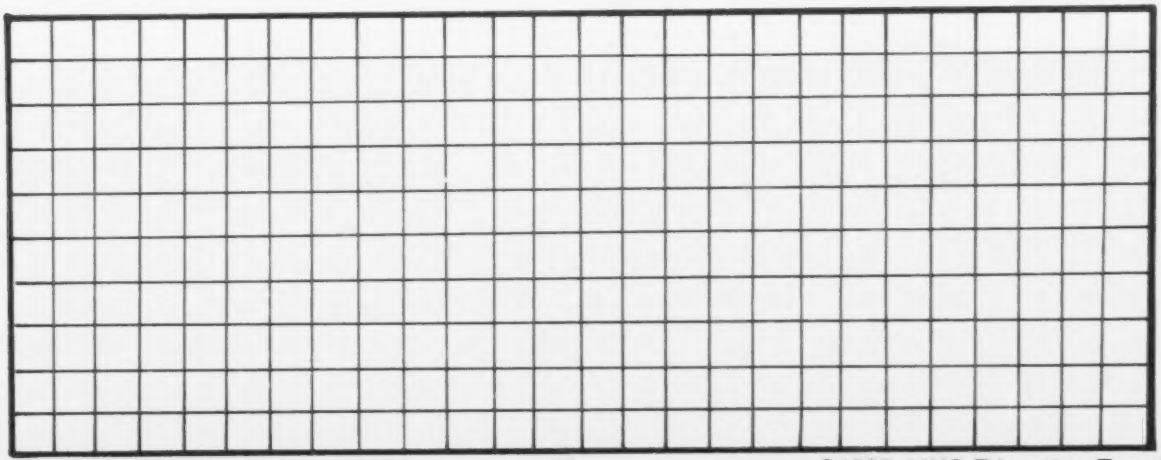
	Prediction	Actual		Prediction	Actual
How many M&M's are in your package?	____	____	Package Weight	____	____
What is the most common color?	____	____	Weight of 1 M&M	____	____
What is the least common color?	____	____	Cost of Package	____	____
What is the class favorite color?	____	____	Cost of 1 M&M	____	____
What is your favorite color?	____	____			



Fill in the prediction part of the data table. Then...
Open your package and count the number of candies.
Now fill in the actual part of your data table.

	TOTAL NUMBER OF M&M'S	No. OF GREEN	RATIO	% of GREEN	No. OF ORANGE	RATIO	% of ORANGE	No. of YELLOW	RATIO	% of YELLOW	No. of LIGHT BROWN	RATIO	% of LIGHT BROWN	No. of DARK BROWN	RATIO	% of DARK BROWN
PREDICTION																
ACTUAL																

Design a bar graph and graph your results.



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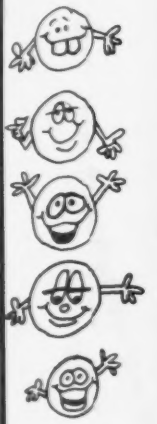
What's in the Bag?
M&M's

NAMES _____
_____
_____

M&M Colors	Sample 1 No.	Sample 1 %	Sample 2 No.	Sample 2 %	Sample 3 No.	Sample 3 %	Sample 4 No.	Sample 4 %	Sample 5 No.	Sample 5 %	Sample 6 No.	Sample 6 %	Sample 7 No.	Sample 7 %	Sample 8 No.	Sample 8 %	Total for Each Color	Average for Each Color
GREEN																		
ORANGE																		
YELLOW																		
LIGHT BROWN																		
DARK BROWN																		
TOTAL FOR EACH SAMPLE																	GRAND TOTAL	

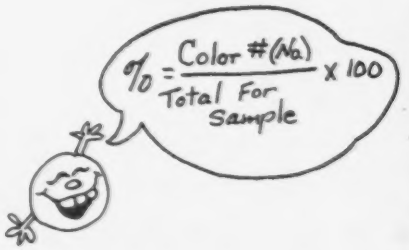


AVERAGE NUMBER OF M&M'S PER PACKAGE

1. How many M&M's are in a bag? _____

2. Based on your samples, what can you say about the colors in a bag of M&M's?
_____
_____
_____
_____

3. Show your results by graphing.



MATH + SCIENCE - A SOLUTION 33.
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What's in the Bag?

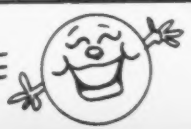
NAMES _____

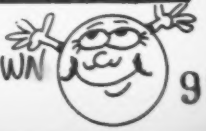
SAMPLE No.

1 2 3 4 5 6 7 8 1 2 3 4 5 6 7 8 1 2 3 4 5 6 7 8 1 2 3 4 5 6 7 8 1 2 3 4 5 6 7 8

20

10





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_____ NAME

DEALING WITH DATA

WHAT PART OF THIS SCHOOL'S POPULATION HAS THE SAME TRAITS THAT YOU HAVE?

FIRST, PLEASE CHECK ☑ EACH TRAIT THAT YOU HAVE.

TRAIT PAIR #1	TRAIT PAIR #2	TRAIT PAIR #3	TRAIT PAIR #4
EAR WIGGLER ☐	TONGUE ROLLER ☐	WIDOW'S PEAK ☐	CHIN CLEFT ☐
EAR NON WIGGLER ☐	TONGUE NON ROLLER ☐	NO WIDOW'S PEAK ☐	NO CHIN CLEFT ☐

NEXT, PLEASE ESTIMATE THE PART OF OUR SCHOOL'S POPULATION WHICH HAS EACH OF YOUR TRAITS. WRITE YOUR ESTIMATE IN THE TABLE BELOW.

THERE ARE _____ STUDENTS IN OUR SCHOOL.

TABLE OF ESTIMATES FOR TOTAL SCHOOL POPULATION

TRAIT PAIR #1	TRAIT PAIR #2	TRAIT PAIR #3	TRAIT PAIR #4
EAR WIGGLER _____	TONGUE ROLLER _____	WIDOW'S PEAK _____	CHIN CLEFT _____
EAR NON WIGGLER _____	TONGUE NON ROLLER _____	NO WIDOW'S PEAK _____	NO CHIN CLEFT _____

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NAME _____

DEALING WITH DATA

LET'S FIND OUT WHAT PART OF OUR CLASS HAS EACH OF THE EIGHT TRAITS! PLEASE COMPLETE THE DATA TABLE BELOW AND PUT OUR CLASS DATA THERE.

TABLE OF CLASS DATA

NOW THAT YOU HAVE SEEN THE DATA FROM OUR CLASS, YOU MAY WISH TO REVISE SOME OF YOUR ESTIMATES FOR THE TOTAL SCHOOL POPULATION. TO DO THIS, PLEASE DESIGN YOUR OWN DATA TABLE AND MAKE YOUR REVISED ESTIMATES IN YOUR DATA TABLE.

SOME OF YOUR CLASSMATES ARE SURE TO HAVE REVISED THEIR ESTIMATES. WHAT KIND OF INFORMATION MIGHT HAVE LED THEM TO REVISE THEIR ESTIMATES?

_____

_____

_____

_____

_____

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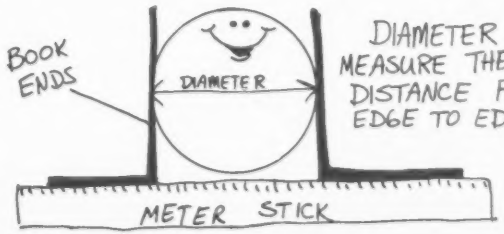
Practically Pi

NAME _____

HOW DOES THE CIRCUMFERENCE OF ANY CIRCLE COMPARE WITH ITS DIAMETER?

CYLINDER	DIAMETER	CIRCUMFERENCE	RATIO = $\frac{\text{CIRCUMFERENCE}}{\text{DIAMETER}}$	DECIMAL CIRCUMFERENCE ÷ DIAMETER
1 lb. COFFEE CAN				
2 lb. COFFEE CAN				
JUICE CAN				
SOUP CAN				
WHEEL				
WASTE BASKET				



DIAMETER: MEASURE THE LONGEST DISTANCE FROM EDGE TO EDGE

CIRCUMFERENCE:

ROLL THE CYLINDER 1 REVOLUTION ON A METER STICK. OR...

WRAP A MEASURING TAPE AROUND THE CYLINDER NEAR ITS BASE

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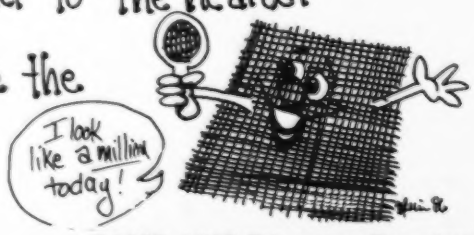
SCREEN TEST

Name _____

What does a million look like?

1. Place 3 samples from a roll of screen into the spaces on this page. Carefully mark the location of each of the corners.
2. Remove the screens and connect consecutive corners of each screen with line segments to form rectangles.

3. Measure the length and width of each screen to the nearest millimeter but record the measurement in centimeters correct to the nearest tenth. (68 mm = 6.8 cm)
4. Make the required computations to complete the chart on the following page.



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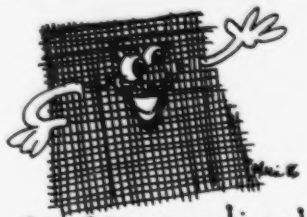
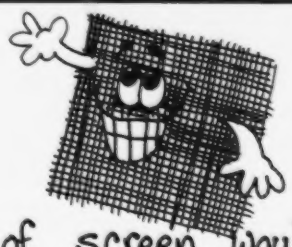
Screen TEST page 2

Name _____

Average Number of Openings per Square Centimeter

Sample	Measurements in cm		Area in cm^2	# of Openings per		Total # of Openings	Number of Openings per cm^2
	Length	Width		Row	Column		
						Total	
						Average	





1. How many square centimeters of screen would it take to contain a million openings?

2. How many square meters of screen would it take to contain a million openings?

Use one sample only for the following:

3. What is the average length *per* opening in the screen?

4. What is the average width *per* opening in the screen?

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Trial & Error Learning

NAME _____

PLEASE PUT DOWN YOUR "TIME TAKEN" IN TOTAL SECONDS.

DAY 1

TRIAL NUMBER	TIME STARTED	TIME FINISHED	TIME TAKEN (SECONDS)
1			
2			
3			
4			
5			

TABLE 1

PLEASE FINISH MAKING THE DATA TABLE.

DAY 2

TABLE 2

PLEASE DESIGN YOUR OWN DATA TABLE!

DAY 3

TABLE 3

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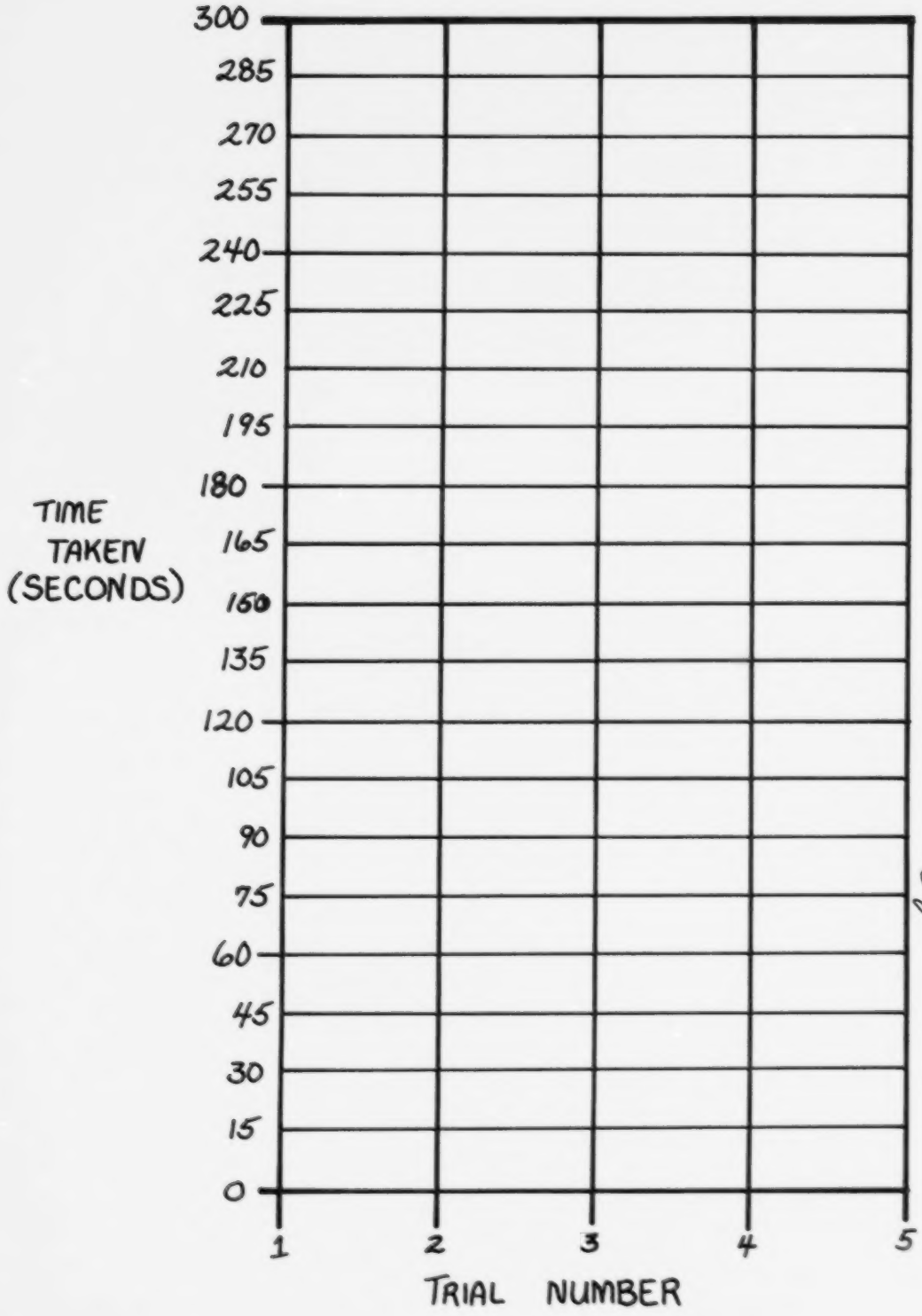
Trial & Error Learning

NAME _____



COLOR KEY

- DAY 1
- DAY 2
- DAY 3

PLEASE USE A PENCIL OF DIFFERENT COLOR FOR EACH DAY'S GRAPH LINE!

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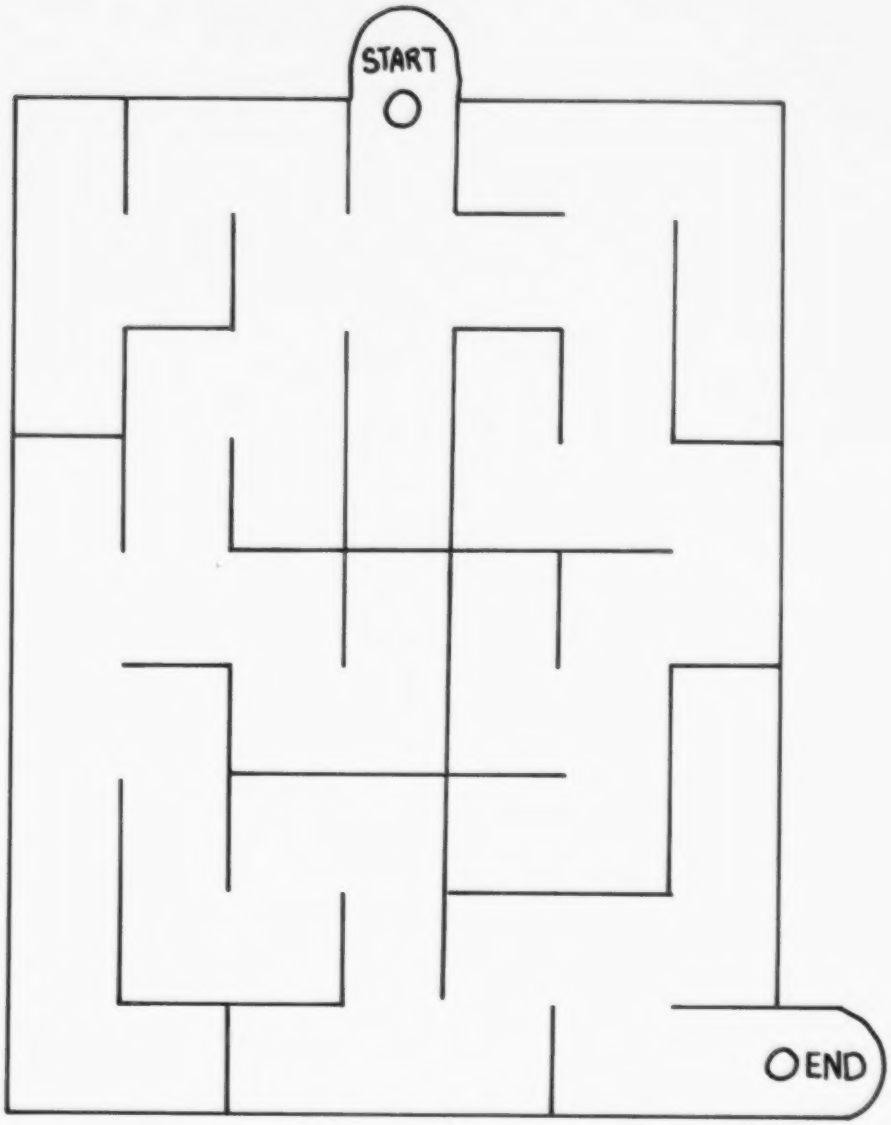
Trial & Error Learning

NAME _____



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Trial & Error Learning

NAME _____

PLEASE WRITE A STORY WHICH TELLS WHAT YOUR GRAPH LINES SHOW ABOUT TRIAL + ERROR LEARNING.

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_____name

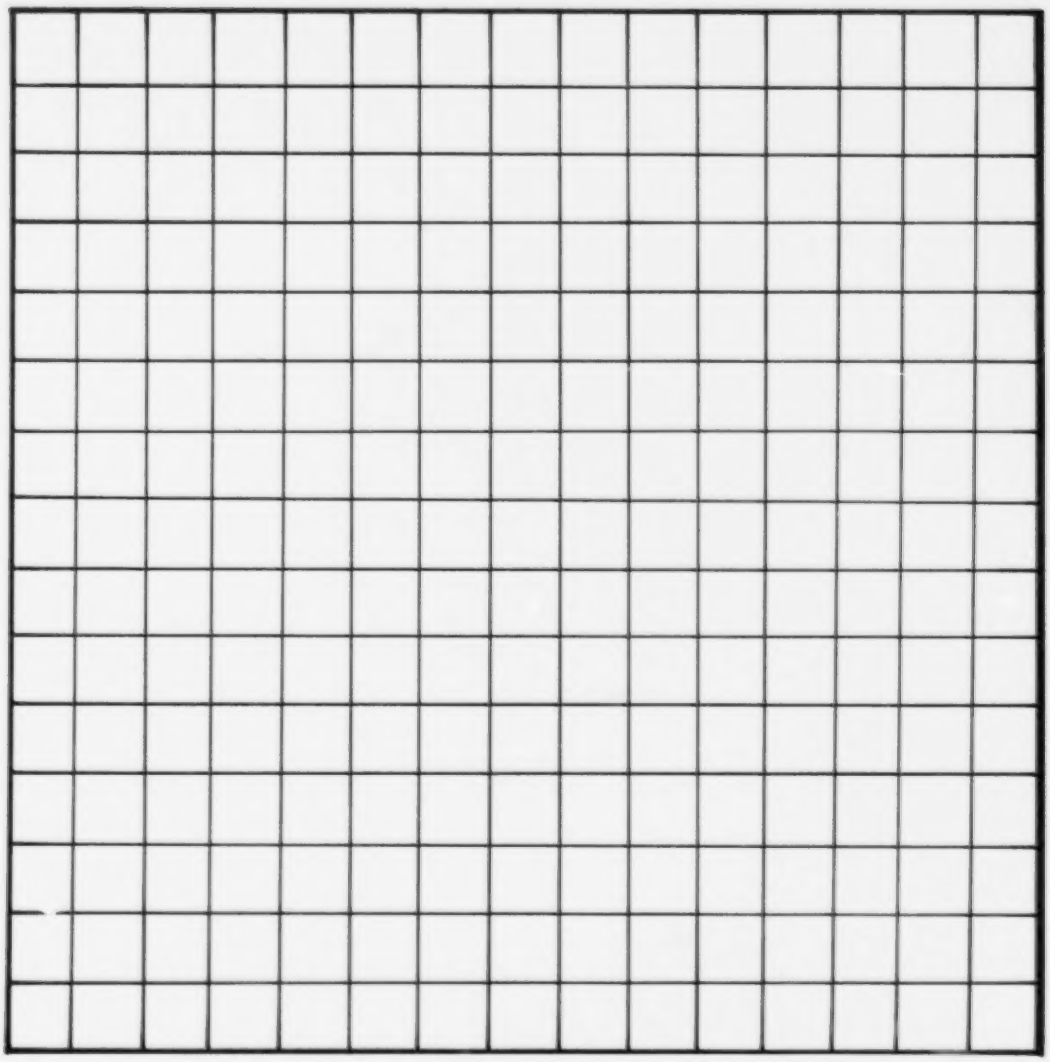
Graph = Feet - EE

Predict the length of your foot in centimeters:

Prediction _____cm

Now, measure: Actual _____cm

Number of



Length of in cm

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Name _____

The Age of Cents

A PENNY FOR YOUR THOUGHTS _____

The members of our team are:

_____ _____

_____ _____

_____ _____

Team Report

1. This is how we tried to get a good sample of pennies:

_____

_____

_____

_____

2. The total number of pennies we studied is _____.

3. Our sample suggests that the following may be true of pennies in circulation: _____

_____

_____

4. Based on our sample, we predict that both the classroom sample and the total population will have approximately these characteristics:
   a. The number of pennies in circulation minted before 1965 is about _____% of the total.
   b. The probability of a coin minted in 1962 to remain in circulation for 20 years is _____.
   c. The largest number of coins in circulation were marked in the year _____.
   d. Over one-half of the coins in circulation were minted in _____ and later.

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The Age of Cents

NAME _____

Tally Sheet : Sort and record the number of coins minted each year.

Year	Tally	Year	Tally

TRANSFER THIS INFORMATION TO A BAR GRAPH

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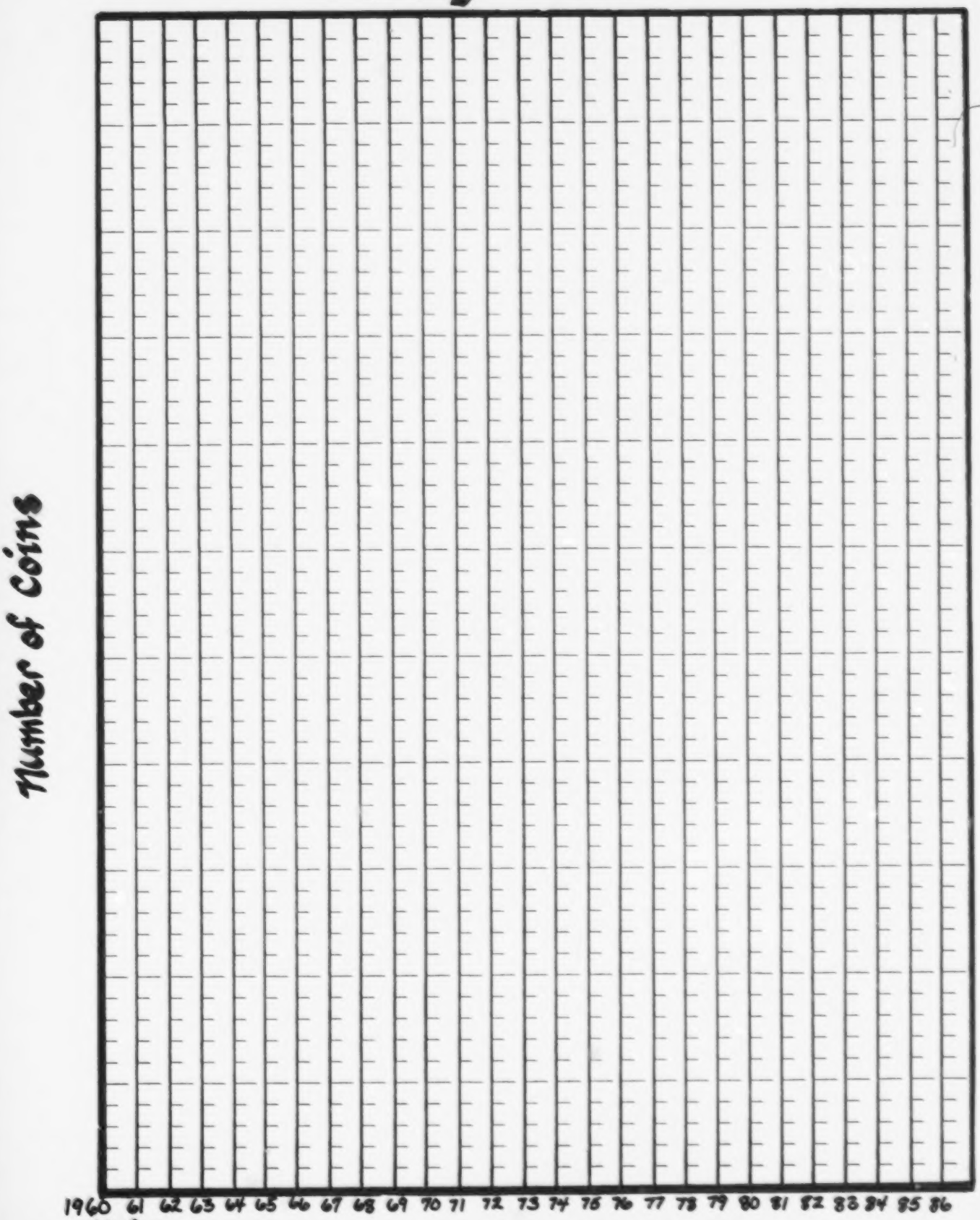
The Age of Cents



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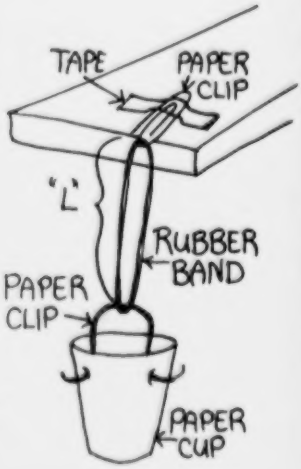
The Rubber Band STRETCH

NAME _____

How Much Does A Rubber Band Stretch?



Please fasten a paper cup "pan" to one end of a rubber band with a large paper clip. Suspend the system from your table or desk top. It should resemble the drawing at the right.

Measure the length of the rubber band as it hangs there. Call its length "L".

L=____mm

Begin your investigation by adding _____ to the paper cup _____ at a time, and measure the length the rubber band stretches for each _____ added. Record the amount of stretch in the table.

Total mass Added (g)											
Total Stretch (mm)											

NEXT, MAKE A LINE GRAPH WHICH SHOWS HOW MUCH THE RUBBER BAND STRETCHED AS MASS WAS ADDED TO THE CUP.

Amount of Stretch in cm

50 45 40 35 30 25 20 15 10 5 0

5g 10g 15g 20g 25g 30g 35g 40g 45g 50g 55g 60g 65g

MASS ADDED

Finally, write a formula relating S (amount of stretch) to M (mass added)

S=___M

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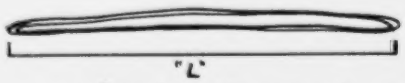
NAME _____

Rubber Band SHOOT!

If You Stretch A Rubber Band, How Far Will it Fly?

First, measure the length of the rubber band with all the slack pulled out of it. Call its length "L".

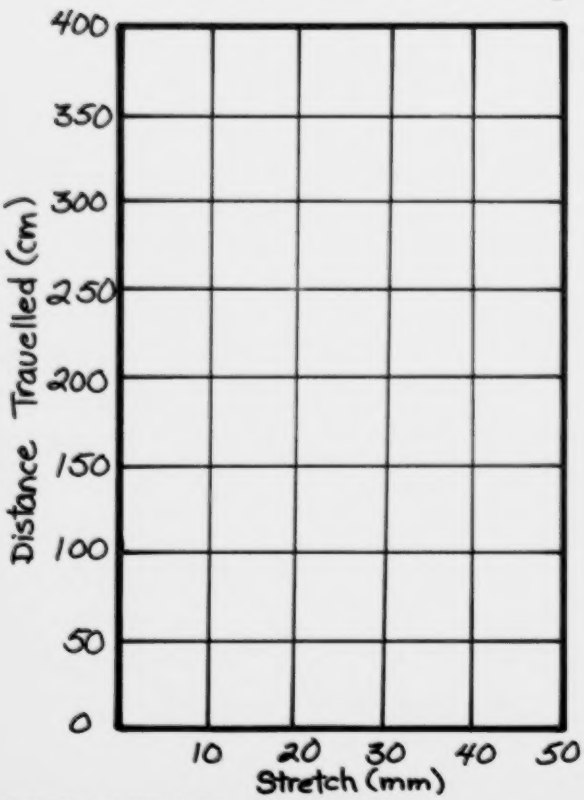
L = _____ mm

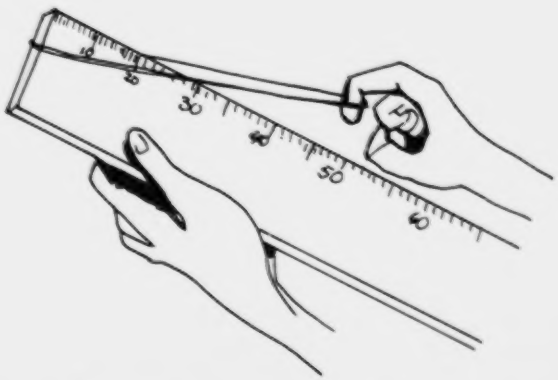


Next, stretch your rubber band on a ruler by 10mm (L+10mm) and release it. Measure the distance it travelled in cm and record this distance in the data table. Repeat the process, each time stretching the rubber band by 10mm more. Complete the DATA Table.

Total Stretch (in mm)	10	20	30	40	50
Total Distance (in cm)					

Now, make a line graph of your data to show how far the rubber band travelled as you increased the stretch.





Finally, write a formula relating D (distance travelled) to S (amount of stretch).

D = _____ S

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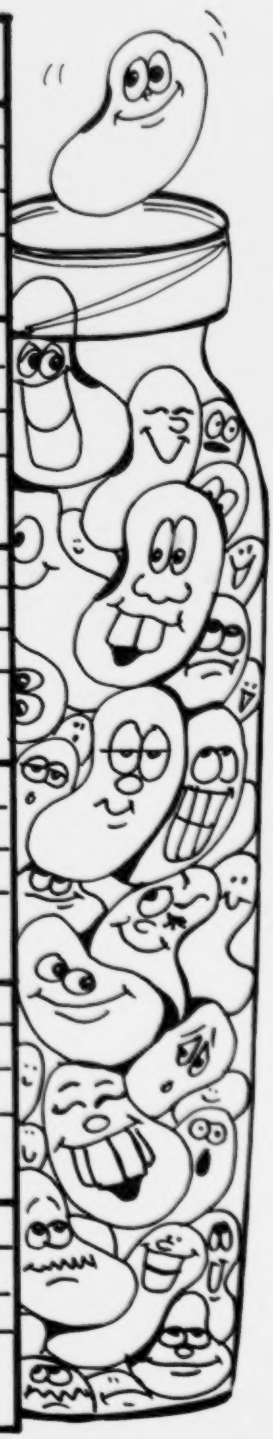
_____ NAME

IT'S BEAN FUN!

JAR	BEAN OR COLOR	SAMPLE 1	SAMPLE 2	SAMPLE 3	AVERAGE
A	WHITE				
	PINK				
	RED				
	COLOR RATIO OF BEANS	_____ : _____ : _____ WHITE PINK RED			
B	WHITE				
	PINK				
	RED				
	COLOR RATIO OF BEANS	_____ : _____ : _____ WHITE PINK RED			
C	WHITE				
	PINK				
	RED				
	COLOR RATIO OF BEANS	_____ : _____ : _____ WHITE PINK RED			
D	WHITE				
	PINK				
	RED				
	COLOR RATIO OF BEANS	_____ : _____ : _____ WHITE PINK RED			
E	WHITE				
	PINK				
	RED				
	COLOR RATIO OF BEANS	_____ : _____ : _____ WHITE PINK RED			
F	WHITE				
	PINK				
	RED				
	COLOR RATIO OF BEANS	_____ : _____ : _____ WHITE PINK RED			



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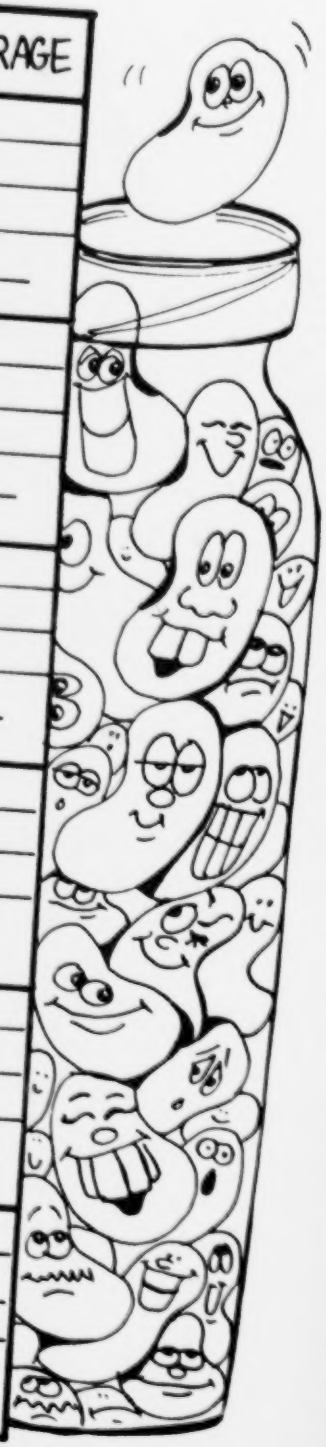
IT'S BEAN FUN!

_____ NAME

JAR	BEAN OR COLOR	SAMPLE 1	SAMPLE 2	SAMPLE 3	AVERAGE
A					
	COLOR RATIO OF BEANS _____ : _____ : _____				
B					
	COLOR RATIO OF BEANS _____ : _____ : _____				
C					
	COLOR RATIO OF BEANS _____ : _____ : _____				
D					
	COLOR RATIO OF BEANS _____ : _____ : _____				
E					
	COLOR RATIO OF BEANS _____ : _____ : _____				
F					
	COLOR RATIO OF BEANS _____ : _____ : _____				



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NAME _____

THE BIG BANANA PEEL!

USE 5 BANANAS TO FIND THE ANSWER

What Part of a Banana is EDIBLE? ____%

FIRST.... Complete the Table.

	TOTAL MASS IN GRAMS	MASS OF PEELING (g)	MASS OF EDIBLE PART (g)	RATIO OF $\frac{\text{EDIBLE (g)}}{\text{TOTAL MASS (g)}}$	PERCENT OF BANANA THAT IS EDIBLE
BANANA A					
BANANA B					
BANANA C					
BANANA D					
BANANA E					
SUM					
AVERAGE					

NEXT.... CONSTRUCT A BAR GRAPH SHOWING THE PER CENT OF EACH BANANA THAT IS EDIBLE.

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
BANANA A											
BANANA B											
BANANA C											
BANANA D											
BANANA E											
AVERAGE											

FINALLY... WRITE A FORMULA TO SHOW THE AMOUNT OF THE EDIBLE PORTION. LET E STAND FOR EDIBLE AND T FOR THE TOTAL.

E= T

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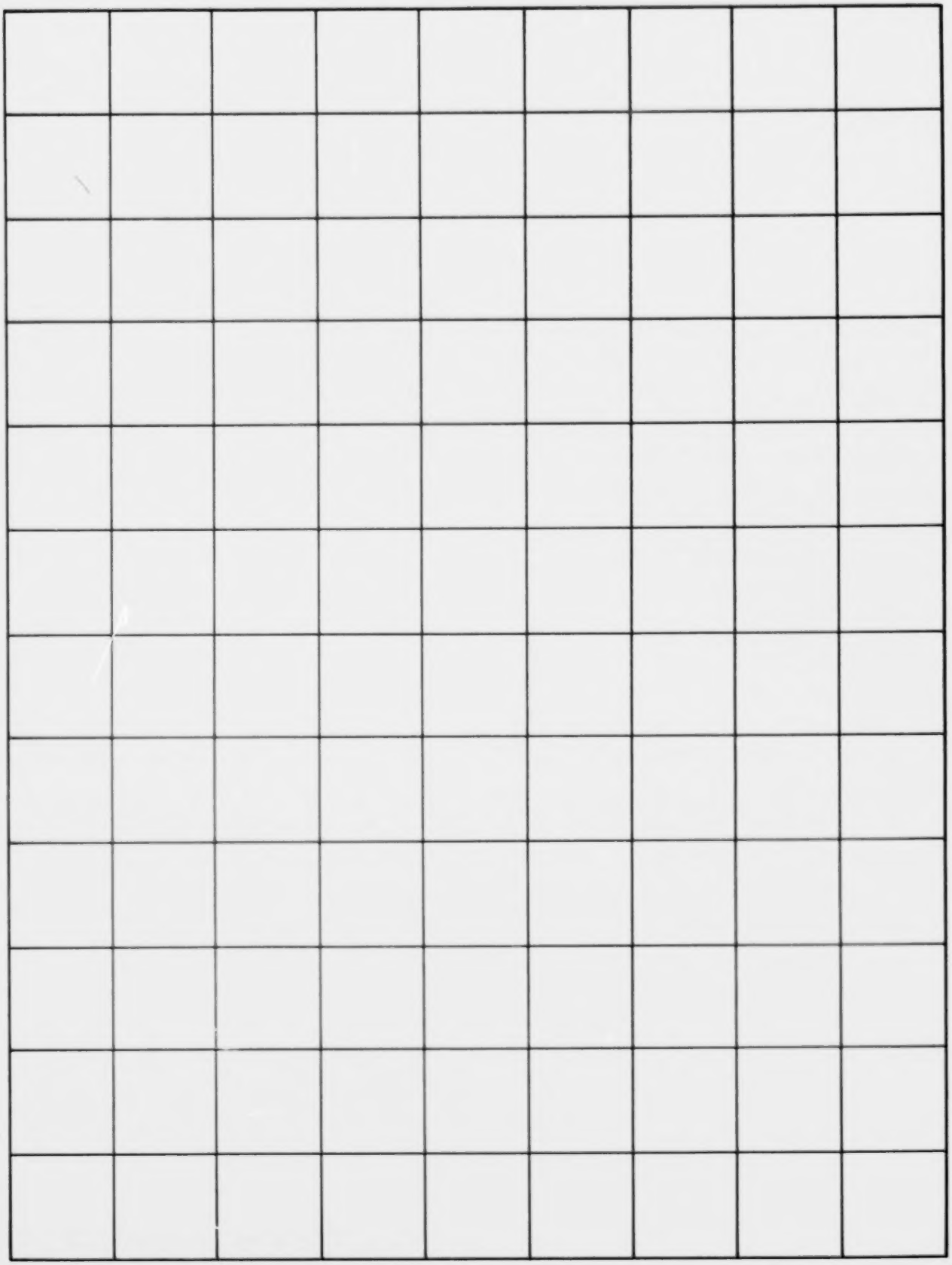

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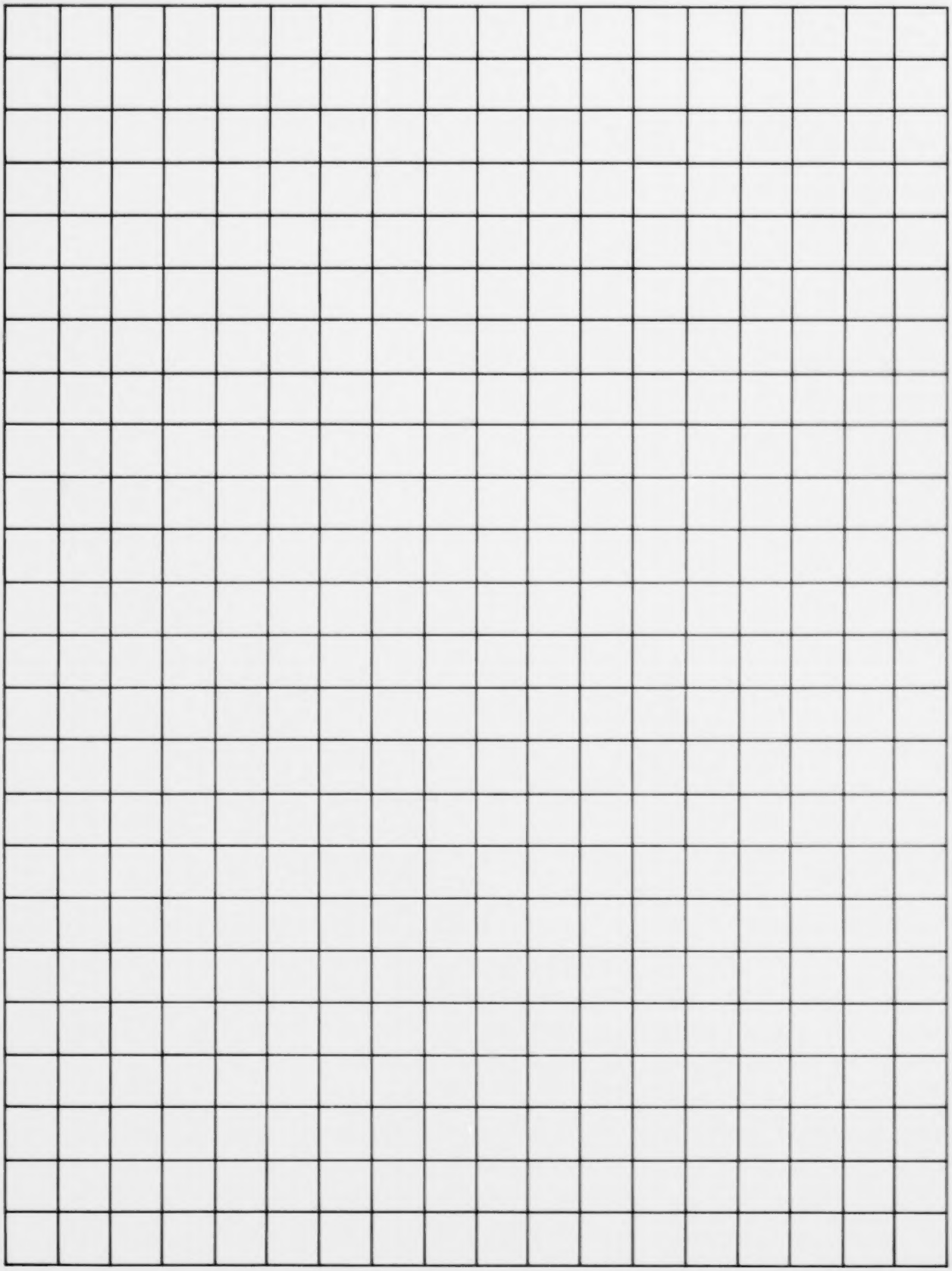

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